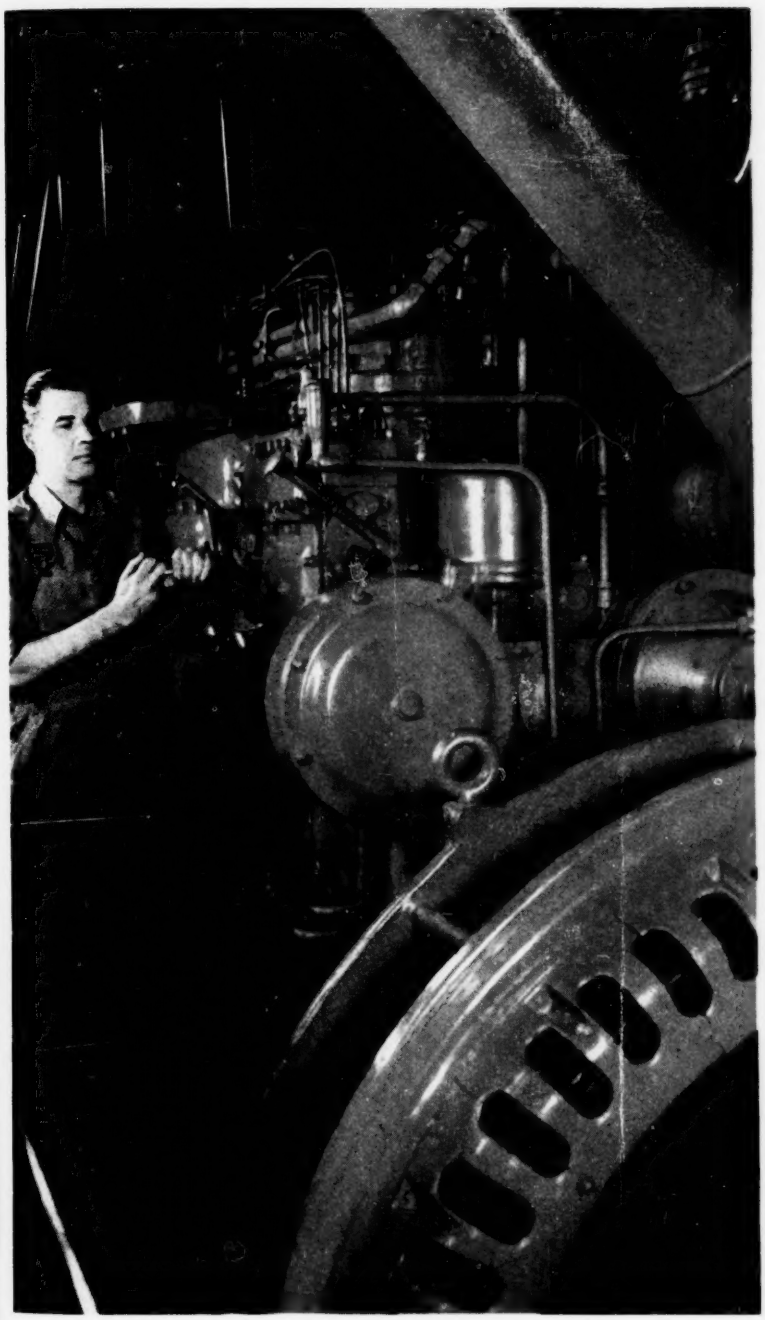
DEPARTMENT OF TECHNOLOGY
BUFFALO

Power Plant ENGINEERING

JANUARY, 1947



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COVER: 343 KW 2-CYCLE DIESEL ENGINE GENERATOR AT ARMSTRONG PAINT & VARNISH WORKS, CHICAGO.

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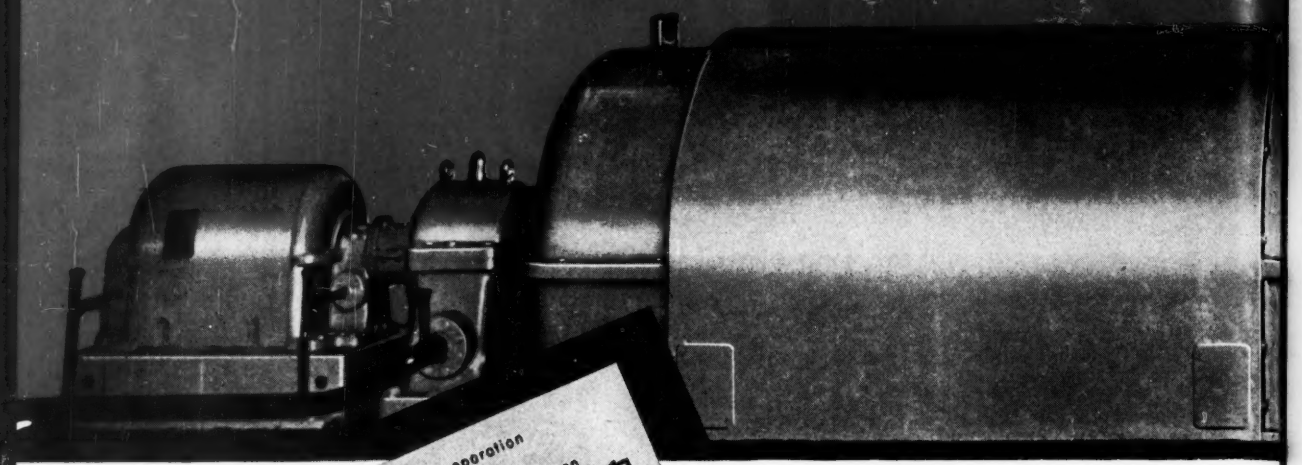
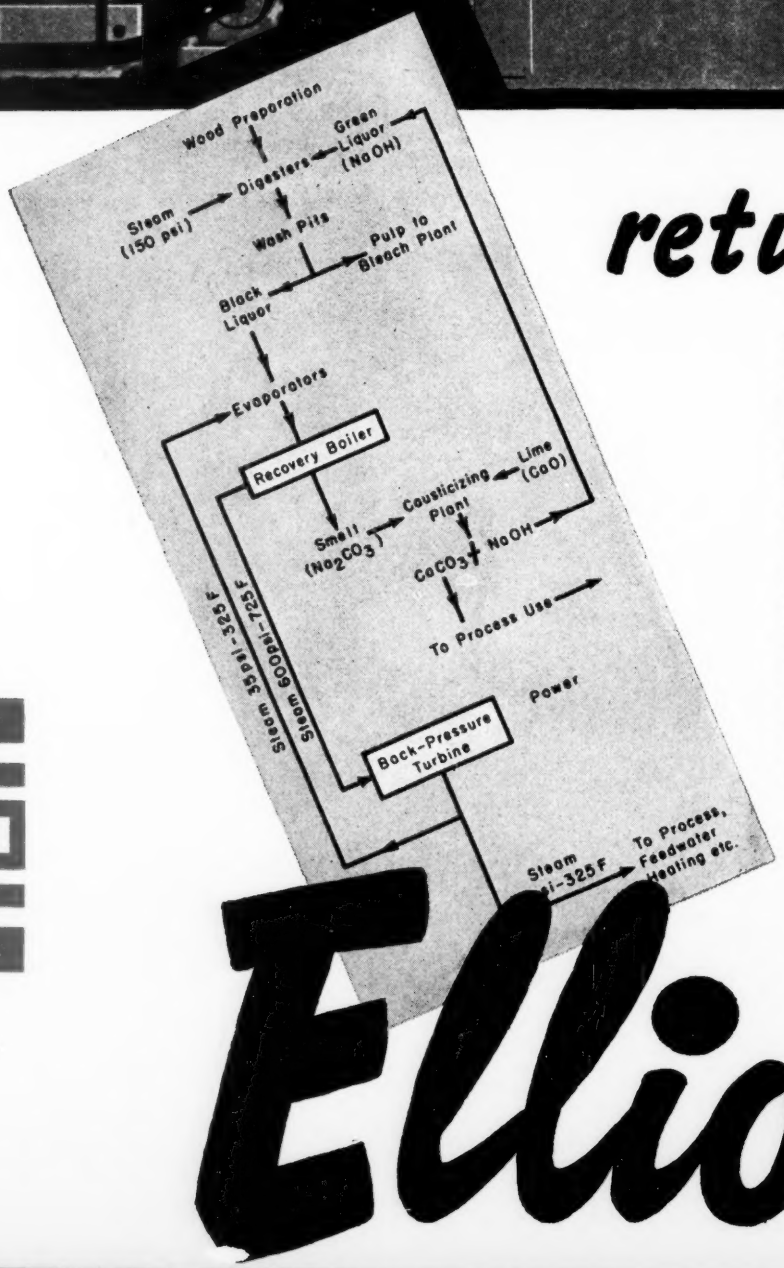
THE POWER ENGINEERING AND MAINTENANCE MAGAZINE FOR EVERY INDUSTRY

XUM

Adventure in economy





returning

This schematic diagram shows how the boiler and turbine fit into the pulp making process. The Elliott turbine-generator is a 3000-kw unit, operating on 600-psi steam, and exhausting at 35 psi to process, feedwater heating, etc.

Another Elliott 4000-kw turbine-generator unit is now being installed in this plant.

There are also a number of Elliott mechanical drive turbines on various pumps, and Elliott synchronous motors driving forced- and induced-draft fans, wood chippers, jordans, and pumps. An Elliott two-stage steam jet ejector is used in process, and Elliott strainers for clearing water. Elliott tube cleaners are also used to maintain boiler efficiency.

Elliott

Power Plant ENGINEERING

January, 1947

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50TH ANNIVERSARY

CELEBRATING 50 YEARS OF SERVICE TO THE POWER INDUSTRY

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Published Monthly by
TECHNICAL PUBLISHING CO.
53 W. JACKSON BLVD.
CHICAGO 4, ILL.

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Subscription Information—The monthly issues are sent prepaid by second class mail. Prices: United States and possessions one year $3.00 and two years $5.00. Canada one year $4.00 and two years $6.00. Pan American countries one year $5.00 and two years $8.00. Other countries one year $7.00 and two years $12.00. Address correspondence about subscriptions to Circulating Division, POWER PLANT ENGINEERING, 53 West Jackson Blvd., Chicago 4, Illinois. Changes of address should give both old and new address and reach us by 20th of month to be effective with following month's issue. The Annual Index is furnished as a part of the December issue.

Entered as second class matter September 8, 1932 (original entry May 1, 1908) at the Post Office, Chicago, Illinois under act of March 3, 1879. Additional entry at Ann Arbor, Mich.

Our 25th Anniversary

IN MODERN ASH HANDLING

To the consulting engineers, public utility companies, and industrial organizations who have contributed so much to the development of all these things through the twenty-five years we have been in business, we express our sincere appreciation.

THE ALLEN · SHERMAN · HOFF COMPANY

Front Lines

THE FIRST THING you probably noticed when this issue arrived was the new cover design, including the full table of contents. A lot of you readers asked for this as an important improvement in the practical usability of every issue. The front cover contents table not only makes it easy to see at first glance all the helpful items in each issue as it arrives, but also serves as a quick aid in finding previous articles pertaining to your current problems. Do you like the new cover? The new picture treatment? Is the contents on the cover a real help to you? A note to the Editor giving your thoughts and opinions will be a big help to us.

ELECTRIC DEVELOPMENTS: A device that lures and electrocutes roaches. An electric soldering iron that heats in five seconds. An electrical device that can open and stack as many as 700 letters a minute. An electronic flash tube, designed particularly for color photography, that has a maximum output of 4,000,000 lumens. An electric saw that will cut a groove in plaster without chipping it; developed for use in installing heating and control equipment. Gas light age is just ending in Kansas City. City officials have decreed the junking of 1,700 gas street lights, to be supplanted by modern electric fiixtures. With copper still in short supply, one electrical manufacturing company has turned to aluminum as a substitute in its building wire and cable division. The company points out that aluminum has high electrical conductivity and "will remove one of the obstacles to building construction."

IN THE IMMEDIATE postwar years corporations will be faced with a temptation which they ought to resist—the temptation to raid educational institutions. With the best men removed from teaching, the training of future scientists would be handicapped. A better policy will be for industry to use able professors as consultants—sparingly. Industry must remember that if it uses the professors too heavily the consulting work will interfere with the quality of the teaching. To make the scientific advances the country needs, postwar research will have to be managed with unusual care by all the agencies involved—universities, government, and industry. Managed wisely, however, scientific research can do more than almost anything else to remove worries about economic slumps and aggressor nations.—J. K. Roberts in *The Frontier*.

COMPLETE German laboratory for Diesel engine research has been received by the Office of Technical Services, Department of Commerce, John C. Green, Director, has announced. Weighing 68 tons and shipped from Germany in 70 crates, the equipment when assembled will comprise one of the most modern Diesel engine research laboratories yet constructed in the United States. The machines, tools, and instruments concerned were taken from the Klockner-Humboldt-Deutsch factory, at Oberusel, Germany, near Stuttgart. They include Diesel engines from one to sixteen cylinders, numerous pulsators, centrifugal test stands, heat treating furnaces, units of industrial X-ray equipment, impact and hardness testing machines, dynamometers, instrument panels, and other testing devices and accessories. After consultation with representatives of the automotive industry, the U. S. Office of Education, and educational institutions, the laboratory will be set up at a suitable technical school. It is possible, Mr. Green said, that by supplementing the German equipment with other equipment already available, two laboratories may be assembled. The Diesel laboratory project has been sponsored by the Automotive Advisory Committee.

A COLORIMETRIC indicating gel that will detect and estimate less than 1 part of carbon monoxide in 500 million parts of air, a sensitivity more than 100 times greater than that attained by former chemical indicators, has recently been announced by the Gas Chemistry Section of the National Bureau of Standards. This gel will also detect 0.001 percent by volume in less than 1 min, and determine physiologically significant amounts (0.01 to 0.4 percent) in approximately 1 min at ground level. The indicator is so sensitive that it is possible to diagnose carbon monoxide poisoning by analyzing exha'd air instead of taking a blood sample for analysis. Developed to meet the wartime demand for a simple and sensitive means for determination of very small amounts of carbon monoxide in military equipment and installations, it offers promise for many peacetime applications. Among the prospective peacetime uses are examination of air in and around busses, automobiles, garages, furnaces and furnace rooms, industrial plants, and civilian transport planes, and in the diagnosis of carbon monoxide poisoning. The tubes may also be modified to serve as detectors of other reducing gases and vapors, including many organic vapors.

WHILE scientists, members of the armed forces, and radio commentators (the last a grumpy and rather let-down group of men) are conspicuously engaged in trying on a new world at Bikini, our readers need have no fear that ordinary businessmen here at home will be caught napping. On the contrary, as eloquent a revelation of the terror and majesty of atomic energy as we have seen comes to us in the form of a message on the back of the small cardboard container in which the Daisy Manufacturing Company, of Plymouth, Michigan, offers for sale a product known as the Buck Rogers Atomic Pistol, Model U-238. With studied casualness, the message is headed "What Happens When Buck Rogers Uses His Atomic Pistol," and the reader is plunged forthwith into an account that will probably make William L. Laurence, the *Times* atom man, radioactive with envy:

Sight carefully through Atomic Beam Director with right eye, allowing for fluctuating barometric pressure.

Squeeze the Neutron Blast Initiator. This liberates a small stream of neutrons from the Uranium Concentrating Magazine. The discharge is indicated by a brilliant flash from the Fission Rate Indicator, and is controlled in intensity by the Fission Control Governor.

The released stream of neutrons enters the Atomic Power Release Chamber, where it bombards the atoms of a secret element, resulting in a controlled chain reaction and a release of atomic energy. This energy flashes out through the Converging Target Focuscope as an invisible and extremely radioactive ray which destroys all evil matter in its path and range.

The Muzzle Blast Deflector prevents any stray energy from shooting back towards the Atomic Pistol user. The Recoil Absorber absorbs all kick resulting from release of tremendous energy developed by Atomic Pistol. The loud report is caused by the high velocity rush of air filling the vacuum created by the burst of atomic energy which destroys all air in its path.

Certain foreign powers may affect to poohpooh this invention, claiming that the secret element is no more than a simple lighter flint. Such offhand dismissals are neither here nor there. The fact remains that *we* are the ones who have the weapon and that it is up to us—if, for the moment, we may speak for the Daisy people as well as for the rest of us—whether we wish to share it with anyone else and, if so, under what safeguards. Whatever the final decision, it is worth noting, as an example of the fruits of free enterprise and Yankee ingenuity (how much Yankee ingenuity do you find in Europe? Asia? Africa?), that Model U-238, complete with Converging Target Focuscope, is now on sale for the absurdly low price of 98c.—*The New Yorker.*

WARTIME research in high altitude flying discovered several interesting facts about the voice. One of these is that the voice decreases in intensity at 35,000 ft to about 1/10 of its strength on the ground. Hearing, however, is unchanged. As a result, special amplifiers, whose amplification automatically increased with altitude, had to be built.—*The Ohmite News.*

TO DETERMINE the corrosive effect of salt water and the damage accomplished by atmospheric conditions along the Atlantic coast on many "seagoing" metals and protective finishes, a testing station was established by The International Nickel Co., Inc. in conjunction with The Dow Chemical Co., and subsequent cooperation of the Aluminum Company of America, the Carnegie-Illinois Steel Corp. and other metal producers in 1935 at Kure Beach, near Wilmington, N.C. Since then over 20,000 specimens have been exposed to the elements to observe the behavior of metals and coatings so that information could be interchanged to permit a most useful appraisal of the proper applications of different classes of material. As corrosion by marine atmospheres is as important as corrosion by salt water, an atmospheric test lot, one acre in size, which has room for 40 racks each supporting from 700 to 900 specimens, is located about 250 yards from the ocean shore. There are some 15,000 specimens in these racks. The effects of atmospheric corrosion are measured by visual observation and by determination of weight loss, changes in mechanical properties, or both. Specimens are furnished by practically all the nation's producers of ferrous and non-ferrous metals. The more vulnerable materials such as unprotected plain carbon steel are destroyed in a year or two. Alloy steels containing small percentages of nickel and other elements are much more durable, while the highly alloyed nickel-chromium stainless steels and high nickel alloys remain practically unattacked.

THE TIME when your employees must file their annual income tax returns is close at hand. Even those of your employees with sufficient exemptions to exclude them from withholding during the year must file a return so long as their gross income amounted to $500 or more. It is apparent, therefore, that a vital need exists for a simplified income tax guide that will answer the numerous questions your employees are likely to ask. "Employee's 1947 Income Tax Handbook," has been designed for that purpose. It explains in detail the various phases of the income tax law as it affects the average wage earner. Special attention is directed to the problems of war veterans. In addition, the booklet contains a complete description of the present pay-as-you-go tax system including the wage bracket tables. With wages subject to so many changes since V-J day, these tables are important to the average employee. The booklet is published by Commodity Research Bureau, Inc., which will quote you quantity prices on it for distribution to your employees. It will save your executive and office staff considerable time that may otherwise be taken up with answering questions about income taxes.

HELPFUL BULLETINS

Answers to many operating and maintenance problems will be found in these new bulletins and catalogs. List paragraph numbers of those you want on coupon below, detach and mail.

BOILERS

1 **Modern Steam Generators**—This new bulletin on steam generators presents the reasons for the high efficiency, dependability and quality construction of the product and shows brief case histories of plants which have saved money by installing this company's equipment. The characteristics of design and construction of a typical unit are outlined through the medium of text and an excellently done sectional wash drawing of the unit. Features of construction of various parts of the boilers cover another two pages in the catalog. Results of tests by independent authorities and "Facts You Should Know About Steam Generating Units," are two other important sections. Ratings, dimensions, firing, measurements and other data are given on the last spread in the bulletin. Springfield Boiler Co.

2 **Packaged Boiler**—This gas-fired packaged boiler, in horsepower ratings from 3 to 15, is described in a recently-issued four-page bulletin. Printed in three colors, the bulletin shows a cross-sectional view of the unit with the flame and gas travel outlined in red. All the construction features of the unit are well explained and a table of dimensions is given which covers all 6 sizes in the line. A dimensioned line drawing accompanies this table. Kisco Boiler & Engineering Co.

3 **Steel Heating Boilers**—Eight pages of information on hand fired and mechanical fired boilers are included in Bulletin B-3000-A. The design and engineering features of the units are presented. Line drawings and cross-sectional photos of the units aid in understanding the description. Titusville Iron Works Co.

AUXILIARIES, ACCESSORIES

4 **Cooling Towers, Pulsation Dampeners**—This general catalog and data book No. 46 gives exceptionally detailed information on cooling towers, fin-fan cooling units, pulsation dampeners, mufflers, and other products and services in the company's line. The section on cooling towers, for instance, first describes the construction of the tower with photos of actual installations and phantom views of construction details. One section, headed, "Selection of Cooling Tower," gives sizing charts, table of cooling tower standards, savings in windage loss and similar engineering information. The booklet is exceptionally well illustrated; 20 pages, separate cover. The Fluor Corp., Ltd.

5 **Engine Heat Recovery**—Heat recovery from internal combustion engines, for use in generating steam, heating water or air, is the subject of Booklet HR-2, issued recently. The sixteen pages in the booklet are filled with illustrations, tables and engineering information on the various types of heat exchangers in the company's line and complete descriptive material accompanies each item. Typical installations are shown, described and the savings made in many cases are told. The Sims Company.

6 **Coal Pulverizer Bulletin**—This four-page bulletin covers the pertinent points of construction and operation of this company's direct-connected pulverizer. Three cross-sectional, diagrammatic wash drawings illustrate (a) the various parts of the unit, (b) the principle of operation of the pulverizer, and (c) the self-contained features of the unit. Each of the illustrations is accompanied by clear, concise copy. Operating advantages of the pulverizer are presented on the fourth page of the bulletin. The Strong-Scott Mfg. Co.

7 **Electrostatic Precipitator**—Here is an 8-page bulletin which briefly covers the history of this "Elex" electrostatic precipitator and tells some of its uses in industry—power, manufactured gas, steel, cement and gypsum, sulphuric acid, paper and pulp plants, aluminum plants, etc. The unit is pictured and the two types of power units are described briefly. Koppers Company.

8 **Heat Exchange Equipment**—Heat exchange equipment for the chemical and processing industry is covered in Bulletin K-212. Stressed in the bulletin is the accessibility and rugged construction of the units and these features are explained by means of both text and photographs. Charts of comparative overall heat transfer and a table of heat conductivity of various metals provide data of use to the designer and specifier. Sectional and dimensioned drawings are included in the engineering data as are a table of corrosion resistance of "Karbate" material (used in the equipment) and a table of dimensions. Alberger Heater Co.

PUMPS, FANS

9 **Motor-Pump Folder**—Bulletin MP-101 is a six-page folder completely devoted to describing the company's combination motor-pump unit. Salient features of design are accompanied by a cut-away photograph of the unit. A two-page table gives the capacities of the various unit under heads of from 15 to 220 ft. Another table presents sizes and overall dimensions of the units. Frederick Iron & Steel, Inc.

10 **Industrial Exhaust Fans**—Bulletin 3576 is a 32-page issue covering a completely new fan designed for industrial exhaust work. Among the features of the bulletin are: a complete description, with photos, of the unit; capacity rating tables for 10 sizes of fans in two models, a total of 20 tables; dimensions and detailed engineering information; tables of pipe sizes and information on exhaust systems. Friction and pressure loss charts also are presented. Buffalo Forge Co.

11 **Blowers and Exhausters**—Bulletin 120-B-13 covers this company's line of centrifugal blowers and exhausters. The folder stresses the wide range of applications where these centrifugals have been, or may be, used. Besides the photographs which accompany the descriptions of the blowers and exhausters, there are many which show typical applications. One set of illustrations shows the units being pre-tested in the shop. Roots-Connersville Blower Corp.

12 **Sludge, Sewage Pumps**—In Bulletin 964-D there are 32 pages of data on sludge and sewage pumps. This revised data book gives complete construction details, dimension tables and installation and operating data. The book is extremely well illustrated with line drawings and photographs. Four full pages of typical specifications are presented. Buffalo Pumps, Inc.

13 **Pressure Blowers**—There are 12 pages bound in a heavy paper cover in this recently-issued bulletin on direct drive, axial-flow pressure blowers. The reasons for the particular design followed in these units are explained in the text and it is also pointed out why these blowers have been made with high strength but with low weight and at a consequently reasonable price. Efficiencies of the fans are explained and performance curves are presented. Complete details of construction are described in the following pages and many charts, tables and drawings supplement the printed descriptions. A price list is included with the booklet. The Moore Co.

14 **Close-Coupled Pumps** — Close-coupled pumps, called Compacunits, are described in Bulletin 242 issued recently. This eight-page bulletin presents some unusually clear and understandable cross-sectional photos of the units and uses these illustrations to point out construction and operation features. A full-page "Composite Rating Table" presents rating information at various heads for 9 different models of pumps. Warren Steam Pump Co.

PIPING, VALVES, PACKING

15 **Tube Compensators Data Book**—Specifications and data for installation of compensators for flexible tubing are contained in this recently-issued data book. The booklet first tells what the compensators are and what they are designed to do. Line drawings are used extensively in the booklet to illustrate the points brought out. Two pages of typical installations are presented in which one column of line drawings shows the installed position, a second column the deflected position and a third column an explanation of the purpose for the compensator in this particular place and its resulting action. A compensating data chart for calculating required tube lengths is presented as are tables of thermal expansion of pipe and standard end fittings. Chicago Metal Hose Corp.

16 **Hose Coupling Handbook**—Twenty pages are included in this handbook and service manual on hose couplings which has been prepared especially for "the man in the field." It is a convenient, pocket-sized book, informative and extremely useful, and has been planned to help reduce operating costs and to increase the usefulness and efficiency of the equipment. Valuable hints and information on the care and upkeep of hose, the selection and installation of the correct hose coupling for various types of equipment, as well as other useful data are presented and illustrated. Hose Accessories Company.

17 **Valve Data Book**—A 248-page catalog has just been issued; it is expected that this book will become one of the outstanding reference publications of the power field. According to the company this catalog sets a new high in the valve industry. It is profusely illustrated with outside and cross-sectional wash drawings of the line and is designed to assist engineers, production men, purchasing agents and management in selecting the right valve for the right job. Ohio Injector Company.

18 **Prefabricated Piping Systems**—Bulletin 546 describes a new and complete prefabricated underground and overhead conduit piping system, a continuous jacketed piping system, and a continuous extruded lead lined piping system. Line drawing in blueprint form are used to show the feature of these piping systems and dimensioned drawings accompany a tabulated list of dimensions. There are 6 pages in the booklet. E. B. Kaiser Co.

19 **Diaphragm Motor Valves**—There are 24 pages and a paper cover in the make-up of this new catalog on diaphragm valves. The introduction to the catalog covers the "Why" and "How" of the unit's design. The remainder of the booklet covers material specifications for the various types of Kontrol Motor diaphragm valves with the exception of two pages of engineering information and charts on "Inner Valve Selection." Kieley & Mueller, Inc.

20 **Metal Packings**—This excellently done four-page bulletin is filled with information on the company's line of metal packing for industrial uses. Clear, understandable line drawings accompany the descriptions of the various types of packing. Packing rings, wiper rings and piston rings also are described and illustrated. France Packing Co.

21 **Flexible Couplings**—This 36-page catalog covers the company's line of flexible couplings. General construction details and features are described and installation and operation data is covered thoroughly. Data regarding each of the several types of couplings includes dimensioned drawings and tabular material of engineering data. The back section of the booklet deals with special applications. American Flexible Coupling Co.

22 **Welded Fittings Data Book**—Bulletin WT-46, an 18-page engineering data book on the company's forged fittings presents a wealth of information on the installation of fittings, their selection and the design of systems. Uses of the three types of outlets are explained in picture and text. Application and structural data tells where and why the fittings are used and shows typical installations. Under the head "Just Four Easy Steps," the bulletin shows the layout, the hole-cutting, tack-welding and welding-in-place details of installation. Handy tips and clearly worded directions make these four steps easy. Tables of temperatures and pressures and tables of stock sizes, dimensions and prices are given as are dimensioned tables and drawings. Bonney Forge & Tool Works.

JANUARY, 19

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23 **Valve Data Book**—Engineering, operating and maintenance data on pressure reducing, differential and overflow valves are contained in Bulletin 461 issued recently; it is a 20 page issue. Large, cross-sectional and external views of each class of regulator are shown together with construction details, exclusive features and complete tables of pressure ranges, sizes and capacities. A handy "ready-reference" index chart at the front of the bulletin simplifies selection of the best valve for any specific industrial application including steam supply to air ejectors, dye tanks, etc. Recommended installations are shown and discussed for remotely adjusted valves, valves with internal parts and valves designed for external control. Approved methods of grinding main valves, tightening controlling valve seats and checking control valve stem clearance are described pictorially. Dismantling, cleaning and assembling information given. Leslie Co.

ELECTRICAL

24 **Motor, Generator Brushes, Carbon Products**—This 46-page catalog No. 25 is an unusually comprehensive issue which covers the complete line of the company's products ranging from motor and generator brushes to welding carbon products such as hold-arc rods, welding plates and paste. There is a huge amount of engineering information crammed into this booklet; brush characteristics are given and cover specific resistance, contact drop, coefficient of friction, abrasive or polishing action, hardness and others. Description of brush grades, grade recommendation. Brush definitions and standards covers dimensions and tolerances, brush surfaces. Information on shunts covers, shunt locations, shunt cable sizes and ratings, etc. Installation of brushes and specific information on how to order brushes is also described in detail. The booklet is well illustrated. Speer Carbon Co.

25 **Electrical Insulation Characteristics**—Technical Publication 21T4, recently published, covers a study of temperature-resistance characteristics of electrical insulation. This 16-page paper summarizes and discusses some of the information on this important subject. The nature of electrical insulation is discussed and, in particular, the wide variations in insulation resistance of such materials due to temperature changes. Graphic analyses are presented together with mathematical formulas. Temperature correction factors have been developed with simplified curves for their use. James G. Biddle Co.

26 **Cable Installation Help**—The equipment presented in this 32-page catalog is designed for the use of cable installation and maintenance crews. Typical of the tools and equipment presented and described are: Cable bands and benders; cable pliers; cable feeder and nozzles; conduit tools; pipe ripper; pipe spreaders; puller rods; etc. Each of the items is well described and an illustration is presented. T. J. Cope, Inc.

27 **Oil Circuit Breakers**—Bulletin 71B6421 describes this company's recently developed "Unitop" oil circuit breaker which is said to be a high voltage, quick clearing outdoor, frame mounted unit, designed to meet the latest A-C power circuit breaker standards in ratings from 15 to 46 kv, 500,000 to 1,500,000 kva interrupting capacity. Excellently done wash drawings aid in the description of the unit's advantages and a two-page spread covers the operation of the "Ruptor" and how it controls release of arc energy. The bulletin is well illustrated. Allis-Chalmers Mfg. Co.

28 **Generating, Substation Equipment**—"More Power to U.S.A." is the title of a new 32-page bulletin (25B6150) which describes and portrays this company's products commonly used on generating, substation, transmission and distribution systems. In concise fashion the bulletin sketches the coverage of the equipment from hydraulic and steam turbines, generators and auxiliaries to switchgear and circuit breakers. Unusually well illustrated, the bulletin portrays installed equipment, parts of equipment, sectionalized drawings and photos, equipment being manufactured and assembled. Allis-Chalmers Mfg. Co.

INSTRUMENTS, CONTROLS

29 **Armored Rotameters**—This company's Rotameters (now named Flowrators) are described in Catalog 40-A; it is an 8-page issue. Cross-sectional views of the units are presented and tables give information on connections, inlets and outlets. Secondary instruments for recording, controlling, integrating and alarm devices are covered with text and illustrations. Special armored Rotameters also are presented and dimension tables for these are given. Fischer & Porter Co.

30 **Strip Chart Potentiometers**—Catalog 15-10 contains 24 pages and tells all about the company's recently-developed strip chart potentiometers. The "continuous balance" principle of operation is outlined and a full page is devoted to an explanation of the operating principle and resulting advantages of these units. Constructional features are covered next and this is accomplished largely by the use of interesting photos of the various parts and operations discussed. Several pages are then used to describe and picture the types of potentiometers and controllers in the line. Thermocouple assembles are shown and tables of engineering data are provided. The Brown Instrument Co.

31 **Boiler Feedwater Control**—This 6-page bulletin 104-C covers description and installation instructions for the company's boiler feedwater controls. The booklet explains the operation of the unit, gives list prices of the controls and probe fittings, presents their specifications, and instructs on their installation and wiring. Each element of the booklet is well illustrated with clear, understandable line drawings. Testing of the installation and servicing of the units are covered, too. Combustion Control Corp.

32 **Liquid Level Controllers**—Bulletin A-100 is a four-page catalog describing this company's Types G and D liquid level regulators. Excellent cross-sectional views of the units are presented and their operational and constructional features are described. Dimensions, capacities and shipping weights are presented. Stets Company.

33 **Water Works Controllers**—Three models of venturi filter effluent controllers for water works are described in Bulletins 321B and 325A. The former is an 8-page bulletin; the latter has 4 pages. Features of the controllers—such as precise control, low loss of head, compact and flexible design and others are described and illustrated. Large, clear photos and line drawings point out the parts of these controllers and tables of dimensions and capacities are given. Builders-Providence, Inc.

MAINTENANCE

34 **Concrete Floor Maintenance**—The title of this six-page folder is "Concrete Floor Maintenance Pays Dividends." It deals with the protective maintenance of concrete floors with the company's product; it explains the action of the product in stopping floor "dusting" and also tells of its action in protecting the floor against the action of acids, grease, oil and abrasion. Illustrations show graphically the typical problem, solution and result of application. Stonhard Company.

35 **Building Maintenance Materials**—This 8-page buletin on building maintenance is said by the manufacturer to be of interest to public utilities, federal and state agencies and municipalities. It describes the company's materials for maintenance of incinerators, sewage disposal plants, water works and power plants. The booklet is entirely composed of tabular material which lists the name of the material and opposite it the purpose which it serves in the various buildings. Stonhard Company.

36 **Dust Collectors**—Catalog No. 32 has 24 pages and a separate paper cover and describes this company's line of dust collectors for grinding, polishing and like operations. Applications, selection of unit, description of filters and prices, installation and similar information is included. Each type of collector has a full page devoted to its description: on this page are illustrations of the grinder and blueprint reproductions for dimensional purposes. Accessories and parts are also shown and list prices are given. Torit Manufacturing Co.

37 **Vacuum Cleaning for Industry**—Two bulletins, 102-F and 125-B, have been issued recently by this company. The first of these is devoted to a description of portable cleaners and the second covers central cleaning systems. Each of the bulletins contains 8 pages. The portable unit is pictured in action in several plants and a drawing is used to point out many of the unit's features. Specifications for heavy-duty, medium-sized and small units are given. Tools which are used with the cleaner also are shown. Many applications of the central unit are shown by photos and line drawings point out how a typical plant may arrange a simple piping system to power the cleaners. The Spencer Turbine Co.

TREATMENT, PROTECTION

38 **Feed Water Treatment**—This four-page folder tells how the company's engineering applied to boiler feed water problems can result in savings. It tells of the different procedures and presents diagrams of equipment arrangement. Typical installations in dairy, cosmetic, aircraft, laundry, and other plants are pictured. Illinois Water Treatment Co.

39 **Pure Water by De-Ionization**—This four-page folder tells about the company's recently announced Chem-Pure De-Ionizer designed to produce chemically pure water at "a fraction of the cost of distillation." The folder presents a typical flow diagram and also a chart which may be used to determine the cost of producing pure water by this method. The quality of the water, low operating cost of equipment and simplified operation are explained. Details regarding the unit are presented on the last page of the folder. Process Equipment Corp.

40 **Fuel Oil Treatment**—A 4-page bulletin, telling about the company's treatment for fuel oil called "No Sludge," has just been issued. Advantages of using the treatment such as stepping up efficiency and reducing operating costs are explained. A list of dosages and applications are also given. A free test offer of the treatment is explained on the first page of the bulletin. Dominion Chemical Co., Inc.

41 **Chemical Feed Systems**—"Electronics in Automatic Chemical Feed Systems," is the title of a newly published booklet which was reprinted from the transactions of the AICE. The paper covers pump design and function, electronic motor speed control, electronic motor drive for controlled volume pumping. Illustrations and charts involved in making the tests and charts of results are printed. The author is Robert T. Sheen, consulting engineer, Milton Roy Company.

42 **Cathodic Protection**—Six-page folder, Bulletin 142, tells about the company's electrical method of preventing rust and corrosion. The principle of operation of the equipment, when used to protect steel water tanks or deep well pumps, is clearly explained. Methods of mounting, output capacities, controls and instruments and other data also are given. Trimount Instrument Co.

43 **Boiler Rust Treatment**—This four-page bulletin describes the company's "Rustoff" chemical which is said to "build resistance to rust- and scale-corroded and congested pipes." The bulletin tells how the treatment works and what results may be expected from its use. A brief description of the company's service department is included. Dominion Chemical Co., Inc.

MISCELLANEOUS

44 **Diesel Engine Cooling Systems**—Bulletin No. 351 is a 20-page booklet, a valuable addition to the reference library of anyone interested in the efficiency of stationary Diesel engines and in lower operating costs. Profusely illustrated with pictures, diagrams and blueprints the booklet will help solve many of the problems encountered every day in Diesel engine cooling. It shows how water jacket scale, overheating, costly breakdowns and insurance rates can be greatly reduced or entirely eliminated. Binks Manufacturing Co.

45 **Insulation Contract Service**—This four-page bulletin explains why "it pays to use" this company's insulation contract service. The exacting needs of various industries and power plants, insulationwise, are pointed out in the bulletin and the methods, material and workmanship of the service are described. Photographs show typical installations. Armstrong Cork Co.

46 **Colloidal Graphite**—This new 16 page booklet, in 3 colors, describes "dag" colloidal graphite and its uses in lubrication, parting, surface coating, impregnation, etc. The booklet contains 5 extended specification tables regarding dispersions in water, oil, hydrocarbons, alcohol and special organics. There are over 25 illustrations of applications, interpretations of the 19 fundamental properties of colloidal graphite, photomicrographs of the material. The last two pages of the booklet list 12 special technical bulletins, 6 published reports and 5 pieces of application literature which are available. Acheson Colloids Corp.

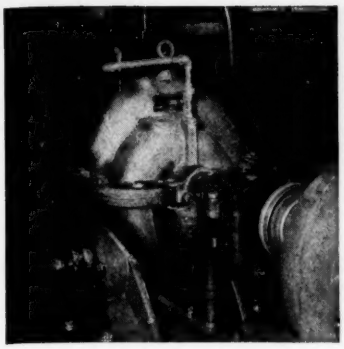
47 **Weldments**—Bulletin SP106 tells about the services of this company's weldry and the weldments turned out therein. The products of this weldry are shown and the text points out how flexible the method is by showing that it makes no difference if the finished product is constructed of light sheet or heavy metal . . . the resulting product can be made to exacting specifications. Pictured, for instance, are gear blanks, eccentric gears, 16-cylinder oil pan assembly, blower bottom housing and many others. Comparative costs of weldments and other methods of fabrication are discussed. Graver Tank & Mfg. Co., Inc.

48 **Chain Hoists**—This 16-page, two-colored catalog G558 has just been issued: it covers the company's line of high speed and differential chain hoists. Care and operation of hoists, points to lubricate, operation principles are but a part of the data provided for the operator. List prices and specifications are given in tabular form for the various hoists and these tables are accompanied by illustrations of the hoists. Hoist parts are shown and list prices are given. Chester Hoist Co.

49 **Concrete, Mortar Shrinkage**—Shrinkage of mortar and concrete—its influence on durability and serviceability, are principal factors affecting it, and its control and elimination—are discussed in this 34-page booklet, "The Action of Embeco in Concrete and Mortars." Explaining the principle of specially prepared metallic aggregate in controlling shrinkage, this booklet describes the use of Embeco for machinery and heavier equipment grouting and patching and repairing concrete. The Master Builders Co.

50 **Magnetic Drives**—A data booklet that starts out with a detailed description of the method of regulating the output of mechanical draft fans with these magnetic drives. Next, a section is devoted to a report on how the drive itself works. Both sections are illustrated and performance curves are given. Parts are illustrated and line drawings show how the drive is adaptable to various requirements. Electric Machinery Mfg. Co.

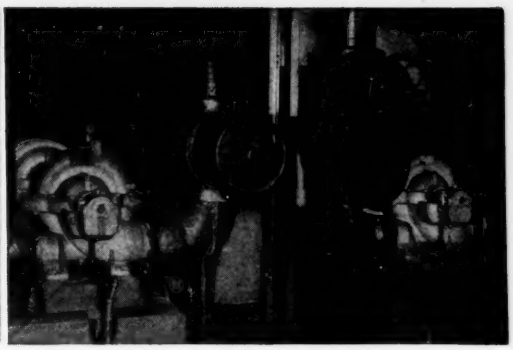
(Continued on page 146)



Two of the several Warren Pumps on duty at SCHRAFFT'S —manufacturers of nationally famous

SCHRAFFT'S CHOCOLATES

Left: Circulating Salt Water for Condensers. *Right:* Circulating Chilled Water for Air Conditioning System.



A "Sweet" Story

for those who need better PUMPS

You get more for your pumping dollars when you specify WARREN

You get the benefit of nearly half a century of highly specialized experience in building a great variety of pumps . . . for Power, Paper, Chemical, Textiles, Mining, Oil, etc., etc.

You get pumps that are smooth-running and free of vibration . . . because they are hydraulically and mechanically balanced.

You get pumps that are given a running test and all guarantees verified before shipment.

You get pumps whose reputation for *Maintained Efficiency* is a matter of on-the-job record in thousands of installations.

You get pumps backed by one of the largest makers devoted exclusively to pump building.

You get personal attention and interest from a nation-wide network of trained service representatives.

Why not put your next pumping problem up to us . . . and to expedite matters, please give us as complete data as possible.

Warren Steam Pump Company, Inc.
WARREN, MASS.

Atlanta Boston Chicago Cincinnati Cleveland Detroit Houston Hartford Los Angeles Minneapolis New Orleans New York Philadelphia Pittsburgh Richmond San Francisco Seattle St. Louis

P5

WARREN PUMPS

Water Conditioning at a LARGE WESTERN COAL COMPANY

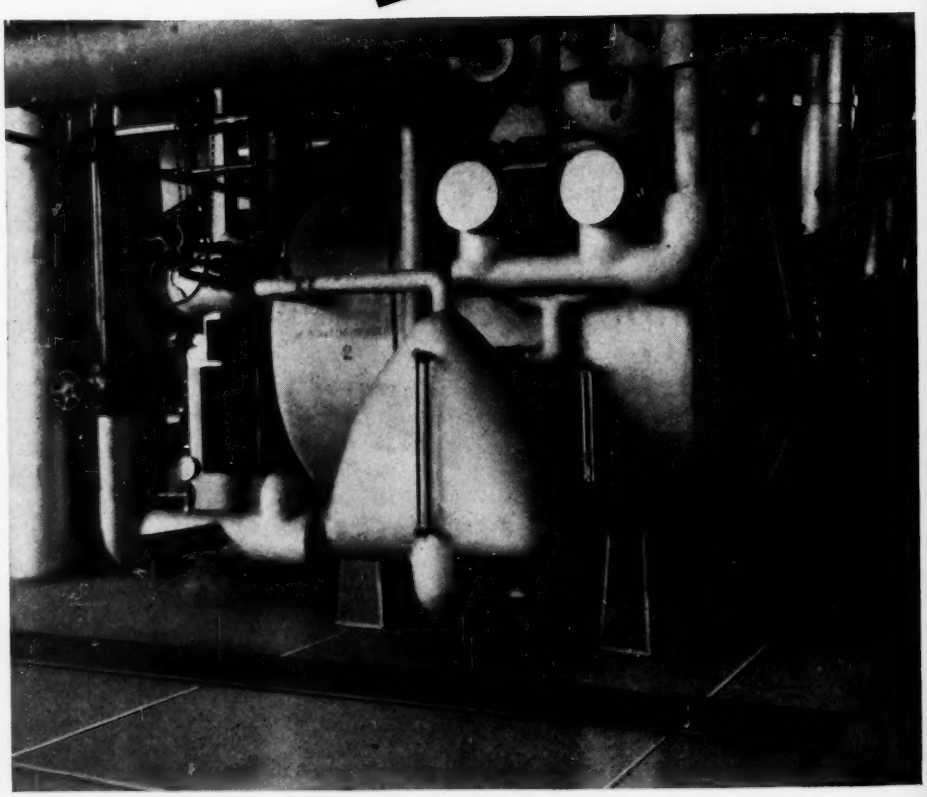
An interesting example of boiler plant water conditioning is the Cochrane installation illustrated here. Shown in the upper photograph is the sedimentation tank of the Cochrane Hot-Process Softener of 16,000 GPH capacity installed outside the building. The lower photograph shows the Cochrane rolled plate Deaerator of 150,000 lbs./hr. capacity mounted on a rolled plate storage tank. Two Cochrane filters and chemical tanks supplement this equipment and are in addition to identical equipment installed in 1936.

The performance of Cochrane Water Conditioning Equipment in industrial applications over the past three-quarters of a century and the reputation of Cochrane engineering in the field of water conditioning are responsible for the continued preference for Cochrane. This experience and knowledge continues unchanged in the organization that is ready to solve your water conditioning problems today. Write for any information you may require along these lines.

COCHRANE CORPORATION
3123 NORTH 17th STREET • PHILADELPHIA 32, PA.

COCHRANE
SINCE 1863

(Above) Sedimentation tank of 16,000 GPH installed outside building.



(Right) Cochrane Deaerator of 150,000 lbs./hr. mounted on rolled steel plate storage tank.

One of a series of advertisements, each discussing trapping practice on a different class of equipment.
HOW TO TRAP
UNIT HEATERS
. . for better heating

Advantages Offered by Armstrong Traps

Whether you use *low pressure* or *high pressure* unit heaters, application of Armstrong traps gives you these important advantages:

1. FULL HEATER CAPACITY. Heaters drained by Armstrong traps are kept dry! No waiting for condensate to cool before trap opens. No cooling leg is necessary.

2. AUTOMATIC AIR VENTING. No separate air vent is required. Both air and condensate pass out through same valve. Minimum maintenance, minimum repair cost.

3. PROTECTION AGAINST CORROSION. Prompt removal of air and condensate from heater minimizes danger of CO_2 or oxygen causing corrosion.

4. LONG VALVE LIFE. All internal mechanism is stainless steel. Valves are same quality as used for 2400 p.s.i.

For complete information on Armstrong traps for heating service, see your local Armstrong representative or write ARMSTRONG MACHINE WORKS, 810 Maple Street, Three Rivers, Michigan, U. S. A.

TRAPPING TIPS*

- Install trap below and close to unit heater.
- If trap discharges to overhead return, use a check valve.
- Use a separate trap for each unit heater.
- Use a trap *Safety Factor* of 3 to 1.
- If heater operates on variable pressures, order trap for highest pressure.
- Use ample size supply and drain pipe lines. Keep supply mains drained with proper traps.

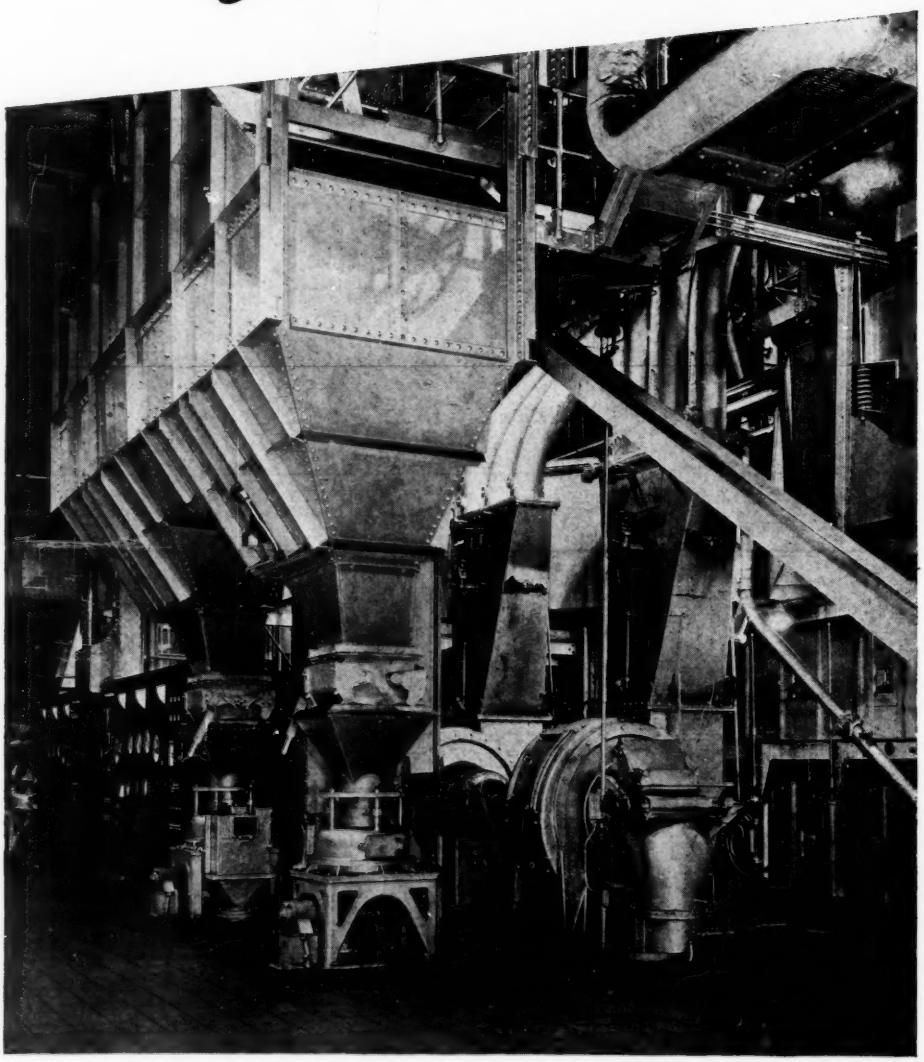
★ Complete data, diagrams, tables, capacities in 36-page CATALOG H, available on request.

See our exhibit at the 17th National Exposition of Power and Mechanical Engineering, Grand Central Palace, New York, December 2 to 7, 1946

ARMSTRONG *Inverted Bucket* STEAM TRAPS

Over a Million in Use...For Power...Process...Heating

Selected since 1937



ESSEX GENERATING STATION, NEWARK, N. J. . . . Four FW ball mill pulverizers installed in this station fire two 605,000 lb.-per-hour steam generators. Shown above are the feeders and exhausters, located on the floor above the pulverizers. Three more mills will soon be erected in Essex.

by PUBLIC SERVICE ELECTRIC AND GAS COMPANY of NEW JERSEY

In 1937, Public Service Electric and Gas Company of New Jersey ordered four Foster Wheeler ball mill pulverizers for the Essex Station. Since then, as additional generating capacity has been added at Essex and other stations, FW ball mills have been selected to fire the new steam generators. Now, to supply vastly increasing power demands, Public Service is building another station at Sewaren. When this goes into service, six FW ball mills will serve its two steam generators, bringing to 25 the total of FW pulverizers in this Company's stations.

Shaft-mounted Pulverizer Exhauster Rotor
Damper trips open when exhauster shuts down allowing room air to sweep conduits and burners clean
Incoming Coal to Feeder
Mill Output Control Damper This damper automatically isolates mill when exhauster shuts down
Rotating Table Feeder
Hot Air from Air Preheater
Classifiers
Rejected oversize dries raw coal entering mill

SEWAREN . . . Six FW ball mills will go into this new station. The phantom drawing shows the double classifier, single feeder and exhauster type mill arrangement.

Records show that operators of FW ball mills enjoy high availability, low maintenance costs. One example — a single mill pulverizing coal of 50-55 grindability was in continuous service 8403 hours, had a yearly availability of 99.03%. In that period it handled 30,371 tons of coal at a total maintenance cost of 1.07 cents per ton.

FOSTER WHEELER CORPORATION • 165 BROADWAY, NEW YORK 6, N.Y.

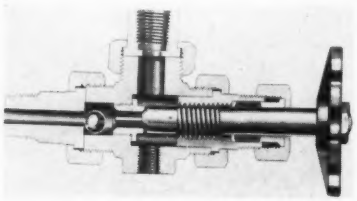
FOSTER WHEELER

NEW EQUIPMENT NEWS

Use the coupon below when you want further information on the equipment described on this page and following pages. Write the identifying letter or letters in the space provided, clip the coupon and send it to Power Plant Engineering, 53 W. Jackson Blvd., Chicago 4, Illinois.

A Union Connected Gage-Valve

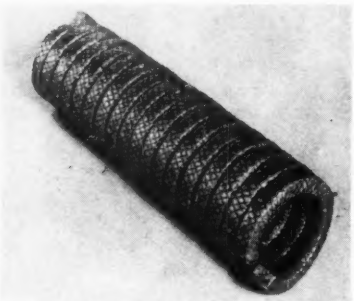
Jerguson Gage & Valve Co. announces a new type of gage-valve (No. 64) with union connection to both the gage and the vessel. This makes it possible to remove the gage for inspection or maintenance without disconnecting the valves. Such a valve is very



useful on installations where it would not be practicable to shut down operations for removing the gage. The two valves are merely closed and the union connection to the gage unscrewed. The gage then can be removed. Operations in the meanwhile continue without interruption.

B Flexible Metallic Packing

The new Raybestos-Manhattan Flexible Metallic Packing is for steam and air rods, centrifugal pump shafts, valve stems, and expansion joints



where the temperatures do not exceed 450 F or surface speed is not greater than 600 ft per minute.

It is a resilient flexible metallic packing incorporating a cross sectional composition of non-frictional metallic foil combined with asbestos yarns; high temperature resistant lubricants and flake graphite for effectively sealing and reducing frictional wear. This construction produces a compressible metallic packing that is sensitive to gland adjustment.

C Paint Over Rust

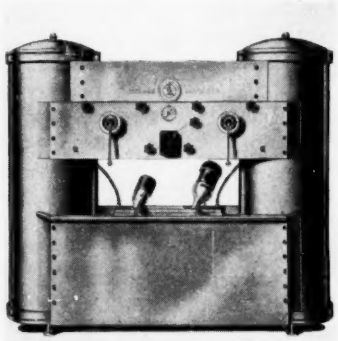
Speco, Inc., has announced a new type of industrial paint which can be applied directly over rusty surfaces without cleaning or scraping. Known as Rustrem (Rust Remedy) this new black paint seals rusty surfaces; stops rust permanently, it is reported.

According to the manufacturer, Rustrem's industrial uses are so wide that no complete list can be compiled. Wherever metal must be protected, regardless of submergence in water or exposure in moist or fume laden atmosphere, Rustrem prevents further oxidation and provides an ideal base for decorative paints.

Broadly, Rustrem is expected to be widely utlized for steel structures, pipelines, standpipes, tanks, grilles, buildings, cranes, etc., in public utilities for metal poles, manhole covers, metal pipe, gratings, hydrants, etc., and in building exteriors for metal roofs, stacks, fire escapes ,gutters, flashing, metal sashes, all metal covers and housings.

D Package Unit Demineralizer

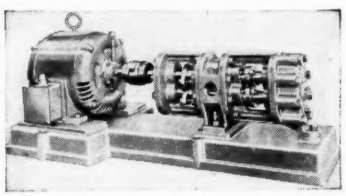
A line of four package unit demineralizers for providing industrially pure water at a fraction of distillation costs has been announced by



Cochrane Corp. The units are designated by reaction tank diameters as the CDM-12 (12 in. dia. reaction tank), CDM-18, CDM-24 and CDM-36. The units are designed for plug-in operation from any convenient 110-v 60 cycle source and are attractively finished along the lines of modern refrigerators and other household appliances. Units are constructed so that all steps of operation are performed and all results observed from a position in front of the panel. Chemical tanks are also charged from this position making the unit suitable for location against a wall or in a corner. All control valves and instruments are located on the panel at eye level. Various reaction materials are applicable to particular condition and those best fitting raw water and effluent requirements

E New Displacement Pump

The Sier-Bath Gear and Pump Co., Inc., has introduced the Gearex Rotary Pump. This pump is of the positive displacement type and comes in internal-bearing models for lubricating fluids



and external bearing models for non-lubricating fluids. It is a medium duty pump available in capacities from 1 to 550 gpm. Discharge pressures up to 250 psi can be maintained with liquids of medium or high viscosity, 50 psi on low viscosity liquids, such as water and solvents.

Advantages of these pumps, according to the manufacturer, are high efficiency, low

JANUARY, 1947

POWER PLANT ENGINEERING

53 W. Jackson Blvd., Chicago 4, Illinois

Please have the manufacturers send me without obligation further information on the equipment indicated by the following letters:

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Please Print Clearly

Your Name .....

Your Title .....

Your Company Name .....

Company Address .....

City ..... State .....

(If you prefer delivery at your home also fill in below)

Home Address .....

City ..... State .....

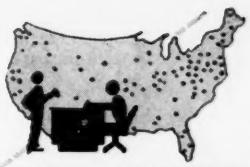
DEPARTMENT OF TECHNOLOGY BUFFALO PUBLIC LIBRARY

Fig. 123
"N-M-D" Globe
(Non Metallic Disc)

Fig. 2125
Bronze Gate

Fig. 1430
Iron Body Gate

Fig. 16-P
"Renewo" Globe



See Your LUNKENHEIMER DISTRIBUTOR for Needed Parts . . . Better Valve Service!

Lunkenheimer Distributors are located in principal industrial centers. They are important links in the Lunkenheimer chain of better, more efficient valve service—service that can save you time, trouble, and money. Our Distributor nearest you can supply you with Lunkenheimer precision-made, perfect-fitting parts, and will gladly help you solve problems of valve maintenance or operations.

He's interested in...

TEN THOUSANDTHS OF AN INCH

If parts do not measure up to the stringent requirements for accuracy, they never enter a Lunkenheimer Valve and never become part of a Lunkenheimer Distributor's stock.

. . . require fewer replacements
. . . cost less per year of service

In every respect—quality of materials, advanced design, finest precision workmanship—Lunkenheimer Valves are built to provide *longer* as well as more efficient and reliable service.

One or two new parts at long intervals make a correctly engineered, ruggedly constructed Lunkenheimer Valve as good as new. All Lunkenheimer parts are precision-made . . . perfectly matched . . . *requiring no special fitting on the job.*

Thus, when you install Lunkenheimer Valves you can look forward to purchasing fewer replacement valves . . . and to easier, lower-cost replacement of present valves with parts quickly obtainable from your nearest Lunkenheimer Distributor.

Remember—in utmost economy plus superior efficiency, Lunkenheimer products offer you *greater value per valve dollar.*

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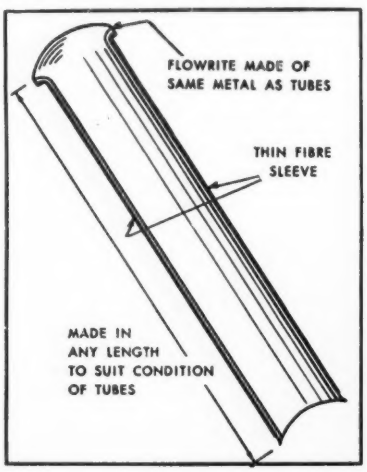
EXPORT DEPARTMENT: 319-322 HUDSON ST., NEW YORK 13, N. Y.

BRONZE, IRON, STEEL, AND CORROSION-RESISTANT ALLOY VALVES, 125 TO 2500 LB. S. P.
BOILER MOUNTINGS AIR CONTROL DEVICES LUBRICATING DEVICES AIRCRAFT FITTINGS

maintenance, vibrationless operation, and pulseless discharge. Rotors of the continuous herringbone type and discharge passages of the proper area insure continuous overlapping displacement of the liquid. The non-contacting rotors are deep toothed and small in diameter to provide low pitch line speeds even at high rpm resulting in quiet and efficient operation. Direct connection by flexible coupling eliminates the need of reduction gears or belts between pump and driver.

Extra deep stuffing boxes are standard equipment. Special alloy materials or jacketed bodies for special services may be supplied to specification. Either vertical or horizontal mounting may be specified.

F Fiber Clad Tube Inserts Here is a new Flowrite tube insert, called Fibreclad, which consists of a belled-end unbreakable metal tube with a very thin fiber sleeve on the outside. Installation is described as very simple; the unit requires no cement, no special care. After installation the fiber swells when in contact with water, producing a very tight seal which prevents leakage. The shape of the Flowrites provides a venturi which reduces water friction up to 80 per cent, according to tests conducted at MIT.



These Flowrites are available for any size tube, in lengths to suit the erosion problem of the particular unit for which they are ordered. They are announced by Condenser Service & Engineering Co., Inc.

G L.P. Radiator Trap Maximum valve opening is affected by a slight temperature difference between steam and condensate in W. H. Nicholson & Cos. new low-pressure radiator trap. For use in vapor and vacuum steam heating service, the trap is of a thermostatic bellows type based on the balanced vapor-pressure principle. The bellows is of bronze, formed from seamless tubing by a hydraulic process which automatically rejects defectives.

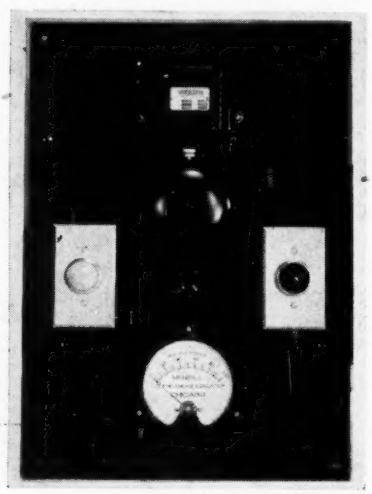
Like the manufacturer's line of high-pressure thermostatic traps, this low-pressure unit features a large diameter valve orifice for maximum water and air discharging capacity. The nickel alloy valve is welded integrally to the bellows, assuring alignment. Features of the trap are the renewable stainless steel seat and the absence of need for adjustment or change of orifice from vacuum up to the maximum pressure of 25 lb.

Furnished in two types, for 200 and 400 sq ft of equivalent direct radiation. Body, cap and union are of corrosion resistant brass; dull nickel-plated exterior finish.

H Two-Stage, High-Head Pump Warren Steam Pump Co., Inc.'s new Compacunit Type CH pump is being produced in capacities from 5 to 300 gpm for heads from 225 to 500 ft. The company's release says that other types are available for various

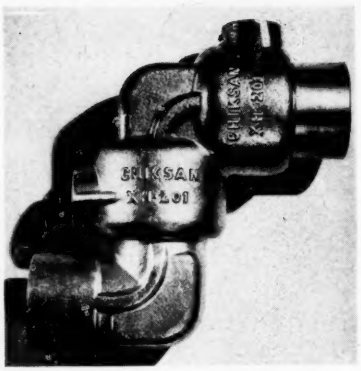
capacities and heads. The Compacunit can be had with either motor or turbine drive, open or enclosed impeller. The unit is described as having numerous applications and can be used in various positions in the plant with complete satisfaction.

J Smoke Indicating System The illustration shows a typical panel board arrangement of this company's smoke indicating system. As shown, the panel has mounted on it an alarm bell, two signal lights and a density meter. The meter graduates from 0 to 100 per cent. Necessary relays are mounted



on the panel. The internal wiring of the panel is complete and terminal strips are provided for outside connections to the line, to the light source and to the light-sensitive unit attached to the breeching. Prices for these systems range from $140.00 to $235.00 fob Chicago. The systems are made by McNeill Engineering Co.

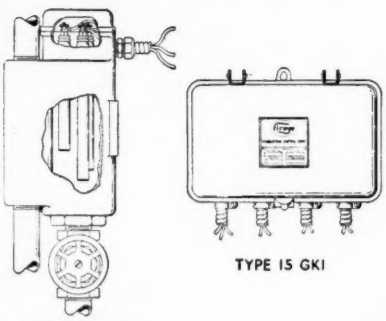
K Swivel Joint The Chiksan Co's. XH (extra high pressure) swivel joint is built for working pressures of 12,000 psi and provides the low torque and positive packing seal-off. Rotating members are steel forgings, machined to close tolerances and with flame-hardened ball races. Full 360 deg rotation with low torque takes place on two rows of hardened



steel balls which also serve to hold the rotating members together under pre-regulated pressure. The packing element is specially designed for high pressure service and is self-adjusting. The new type XH employs no bolted flanges, locking rings or stuffing boxes. There is nothing to tighten or adjust. High pressure lubricating fittings provide for positive lubrication of the bearings. Inside diameter is unobstructed, permitting full flow of liquids, gases and vapors with minimum friction loss and turbulence. End connections are of the high pressure, tapered thread type. It is recommended for all high pressure services to 12,000 psi where maximum flexibility, easy turning, minimum maintenance, long life and maximum safety are essential.

L Feedwater Control Fireye Boiler Feedwater Control Type 15GK1 is an automatic control for maintaining desired boiler water level and instantly turning off fuel supply and sounding an alarm at a dangerously low-water level. This equipment is described as completely maintenance-free—contains no moving parts, no floats or bellows seals, no vacuum tubes requiring replacement, nothing to wear out or fail in service.

It is an alternating current control that combines a probe circuit and transformer in a unique manner to operate a direct current relay through a rectifier. Direct current is used in the relay circuit to eliminate chatter, increase contact pressure, and make possible the use of low alternating current voltages in the probe circuit. The problem of electrolysis is eliminated. Closure of the probe circuit alters the magnetic field of the transformer in such a



TYPE 65 BF3

TYPE 15 GK1

way that current is generated in the rectifier-relay circuit energizing the relay.

This equipment consists of Control Type 15GK1 and Probe Fitting Type 65BF3. The probe fitting is mounted parallel to

Everything for your Piping Job from One Complete line

The type of installation—or size of the job—makes no difference. Whatever your piping needs—selecting from the *complete* Crane line assures the maximum benefits of standardization.

For this ammonia compressor installation, for instance, one order to your Crane Branch or Wholesaler covers all the piping materials. Specifying, buying, and erecting—every step of the job is simplified because you deal with a single, responsible source. And watch how it speeds piping maintenance work.

With top quality assured by Crane Co.'s 90-year leadership in the field, standardizing on Crane equipment gives you this 3-way advantage:

WORLD'S MOST COMPLETE SELECTION of valves, fittings, pipe, piping accessories, and fabricated piping—in brass, iron, and steel—for all power, process, and general service applications.

ONE RESPONSIBILITY for piping materials—helps you to get the best installation, and to avoid needless delays on jobs.

OUTSTANDING QUALITY in every item—assuring uniform durability and dependability throughout piping systems.

CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill.
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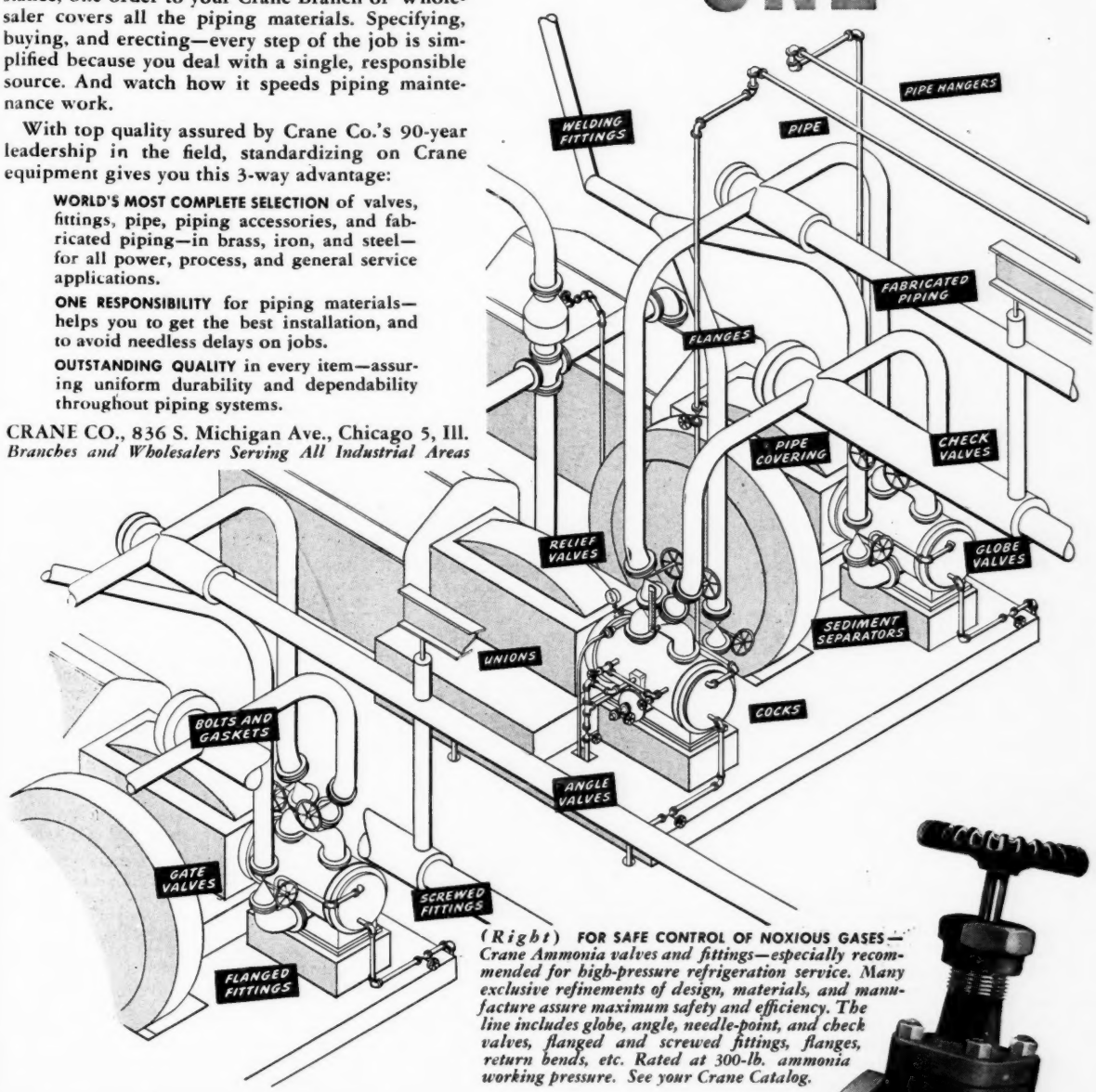
SOURCE OF SUPPLY
RESPONSIBILITY
STANDARD OF QUALITY



(Right) **FOR SAFE CONTROL OF NOXIOUS GASES**—*Crane Ammonia valves and fittings—especially recommended for high-pressure refrigeration service. Many exclusive refinements of design, materials, and manufacture assure maximum safety and efficiency. The line includes globe, angle, needle-point, and check valves, flanged and screwed fittings, flanges, return bends, etc. Rated at 300-lb. ammonia working pressure. See your Crane Catalog.*

EVERYTHING FROM . . .

VALVES • FITTINGS
PIPE • PLUMBING
HEATING • PUMPS

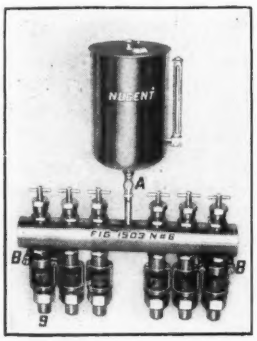
CRANE

FOR EVERY PIPING SYSTEM

the water column and wired to the control. There are three probes within Type 65BF3 fitting. The top and middle probes determine the high and low level at which the boiler feedwater pump is turned off and on to maintain constant water level. The lowest probe defines the danger point below which water must not fall. Should water drop below this safety probe, Fireye immediately shuts off the fuel supply and sounds an alarm.

Fireye Boiler Feedwater Controls are supplied for every make, type, and size of steam boiler, with any method of firing and for any pressure to 300 psi. It is announced by Combustion Control Corp.

M Multiple Oiler The latest addition to the line of filter and lubrication specialties manufactured by Wm. W. Nugent & Co., Inc. is a new heavy-duty multiple oiler. This new unit has a reservoir tank capacity of three pints, and is

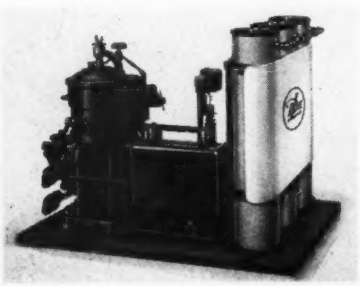


available with a string of sight feed valves in multiples of from 2 to 23 feeds. It is designed to be used on any machine that requires drop feed or small stream.

Following are some of the design features of this new product. Removable strainer in each sight feed, together with the glass, may be removed for cleaning without the use of tools, or without stopping the flow of oil. (No piping or tubing to remove). Minimum amount of glass used—well protected. (Reservoir tank gage glass has protecting sleeve along its entire length). Oiler is equipped with supporting clamp having threaded studs to screw into the machine to be oiled. Dust-tight reservoir cover, easily removed for filling operation. Union outlets on each feed are available in sizes from ⅛ in. to ⅜ in. ips female.

N New Oil Purifier The De Laval Separator Co. has announced the "Puri-Filter"—a combination of the company's "Uni-Matic" Oil Purifier and the Fram "Filcron" Filter.

Although the "Puri-Filter" is now announced for the first time, the operation of the De Laval purifier with the Fram filter



has been tested at several power stations over the past two years. The manufacturer's claims for the product are based on the records made on these field installations.

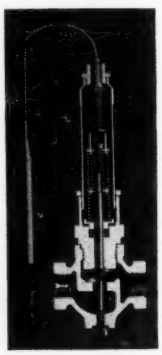
The "Puri-Filter" will enable the Diesel operator to secure the advantages of purifying Diesel lubricating oil by centrifugal force and by positive filtration. Heretofore he has been forced to choose between centrifugal force, which removed most solid impurities and all water, and filtration which in cleaning the oil also restored a good measure of color but which provided no protection against water. With the "Puri-Filter," Diesel lubricating oil can be maintained both clean and dry—the maximum protection for every engine.

The De Laval "Puri-Filter" combines a De Laval "Uni-Matic" continuous centrifugal, complete with dirty-oil and clean-oil pumps, with two or more Fram Micronic Filters. In addition, a thermostatically controlled non-carbonizing heater, and all necessary inter-connecting piping and wiring are furnished. The entire unit is compactly mounted on a sturdy structural steel base. To place the "Puri-Filter" in operation, it is only necessary to make connections to the oil sump and to the power supply. For the first time, the Diesel operator can continuously purify and restore his lubricating oil to "like-new" quality and appearance.

The centrifuge is fitted with a constant efficiency disc type bowl, most effective means of utilizing centrifugal force as a purifying agent ever devised. The filter unit is a low-cost porous cellulose cartridge which will remove all solid particles down to one micron (0.000039 in.) in size.

O Temperature Regulators A new type of self-contained, direct-operated temperature regulator for gas control to process heating, designated as Class MG-2, has been announced by Leslie Co.

Supplied with screwed ends in ⅜, ½ and ¾ in. sizes, these bronze body tem-

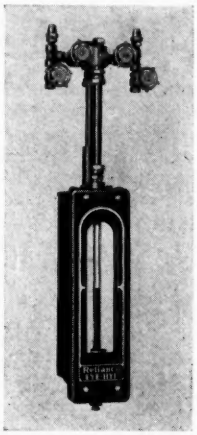


perature regulators operate over standard temperature ranges from 20 to 600 F, at inlet pressures up to 25 psi maximum. They are designed specifically for hot water heaters, oil treaters, industrial baking ovens, cookers, drying ovens, and similar equipment where accurate gas-fired control is desired, and where product quality is dependent on temperature control and economy of operation is important.

All trim is bronze, with renewable valve disc and steam assembly. Various bulb and bulb casing materials are available and the rugged liquid expansion type thermostatic element has a piston guided bellows. A free moving valve stem has yielding springs which prevent overstressing of bellows at "over range" temperatures. An unexposed pressure sealed stuffing box prevents unauthorized tampering with the regulator, and costly over-rides in temperature are eliminated by adjustment of the pilot flame to the lowest point the burner permits.

No attention is required during operation. Since these regulators only pass the volume of gas required to do the job correctly, regulation of temperatures below the boiling point results in fuel savings of 15 per cent at 205 F; 20 per cent at 200 F and 30 per cent at 185 F.

P Liquid Level Indicator The Reliance Gauge Column Co. announces a newly styled, newly engineered model of the Eye-Hye remote reading liquid level indicator which they



have marketed for 10 years. Besides giving the device a new, modern face plate, the construction has been altered to achieve greater compactness and certain structural advantages. Use of a plastic diffusing screen improves the distribution of the interior illumination. The case has been made drip-proof and the arrangement of the interior more accessible for cleaning and renewing of illuminating lamp. The new Eye-Hye Model E-32 is the first of several which will replace the original series.

Q Explosion-Proof Alarm Systems The Air-O-Larm, a pneumatically operated mercury switch assembly, has been made available to provide explosion proof alarm systems under hazardous conditions at predetermined values of flow, liquid level, temperature or pressure. The auxiliary switch contacts can be wired to provide visual or audible readings, or both, on any installation with one or two-pen recorders, indicators and controllers among a group of 15 models. Brown Instrument Co. makes this alarm system.

The complete system consists of two assemblies: (1) A nozzle-flapper mechanism, and (2) A bellows-switch assembly.

The nozzle-flapper mechanism, located inside the instrument case, (see photo) is operated by the instrument pen through special linkage. The bellows-switch assembly consists of two bellows that are actuated by an increase in air pressure when the flappers cover the nozzles.

The two mercury switches, operated by the bellows rods, are located in an explo-

How near *PERFECT* is your boiler water treatment?

LET'S look into *your* boiler plant. Perhaps you, as many other power plant engineers, put up with excessive blow-downs and outages, scaling, corrosion and foaming as necessary evils. That adds up to costly time delays and high maintenance costs.

But what about your present boiler water treatment? Does it minimize scale and corrosion? Does it eliminate carryover? Does it reduce blow-down and save fuel? In other words, how near *perfect* is it, and *can* it be improved?

There's no one solution to all boiler water problems. It takes more than just adding a few chemicals to the system. Good results require a complete *individualized* water conditioning service that includes initial investigation, plant control, a daily testing program, periodic check-ups, analyses of water samples and regular engineering reports on plant operation. Such a service is rendered by the Betz organization. Write for details on what Betz engineers might do for you . . . W. H. & L. D. BETZ, *Gillingham & Worth Streets, Phila. 24, Pa. In Canada: Betz Laboratories Limited, Montreal 1.*

BETZ

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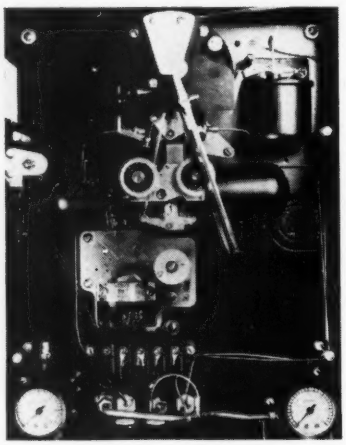
sion-proof housing. The full assembly is mounted as a single unit on either the back of the instrument case or below it.

The entire alarm system is independent and separate from the instrument control system. The air-alarm contacts depend only upon the position of the pen on the scale

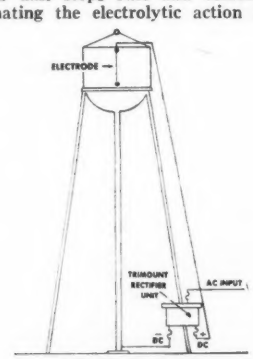


or chart and can be independently set at any point from zero to full scale. The mercury switches permit operation in a wide variety of circuit arrangements, the actions being summarized in the accompanying table.

The assembly can be adjusted to an extensive variety of installations, for many conditions. Being of an explosion-proof design, the equipment can be installed outdoors without additional protection. The unit construction of the bellows-switch assembly permits remote mounting; it can be actuated from any pneumatic loading station. If desired, it can also be remotely located and operated from the controlled air pressure of an on-off controller, a convenience when employing the unit at an indicated alarm point which requires frequent change.

R Cathodic Unit Prevents Rust The Trimount Instrument Co. announces a new Cathodic Rectifier to provide rust and corrosion protection for steel water tanks and deep well pumps.

This unit stops rust and corrosion by eliminating the electrolytic action on the



ELEVATED WATER TANK

metal being protected. Ordinarily, a steel tank or pump acts as a galvanic battery, the submerged part forming the anode, which is subject to rapid rusting, pitting, or corrosion. With a Cathodic Rectifier Unit the flow of current in the tank or pump is reversed by introducing a cathode which is charged by the rectifier. The metal of the tank or pump thereby becomes the cathode and is not subject to corrosion or rust.

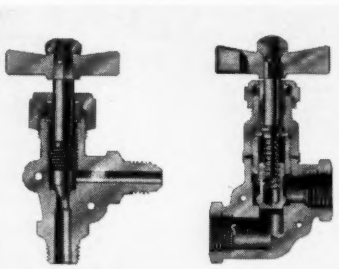
The unit is contained in a weather-proof steel cabinet and has a d-c output capacity of 2-5 amp at 31-50 v (100 to 150 watts) —sufficient to protect submerged areas up to 10,000 sq ft. Preferred a-c input is 110-3-60, but the unit can be equipped to take other a-c characteristics.

S Industrial Valve Line Production of a series of industrial valves incorporating a number of design features new to this field is announced by Parker Appliance Co.

Available in needle and globe types in sizes up to 1 in., and in both angle and offset designs, the new valves are unusually small and compact by reason of forged brass bodies. The forging process produces a strong grain structure which makes possible a light-weight, well proportioned design with high strength.

Both the needle and shut-off types are available in six variations of connection arrangements, introducing a new flexibility in use. Straight-line types are produced with female pipe threads, or with tubing threads for the use of flexible tubing. Angle types are provided with female pipe threads, with tube threads, or with male pipe threads at the inlet connection and either tube or female pipe threads at the side outlet.

These variations enable the new valves to be directly connected into either pipe or flexible tube systems without the necessity



for extra nipples, adapters, and the like, thus assuring a neat, efficient, and easily serviced installation. Tubing is accommodated in a range of from ¼ in. to 1 in. outside diameter, pipe from ⅛ in. to 1 in.

All valves in the series are provided with integral mounting lugs for convenience in securing valves to brackets or panels to insure long-life, leak-proof connections in installations where vibration is a factor. Bolt holes are drilled to accommodate standard-size bolts.

An important reduction in pressure drop has been achieved in the offset valve design, by the elimination of pockets, angle ports and intricate chambers which unnecessarily consume pressure. The streamlined path instead provides free-flow characteristics which under test have proven to decrease pressure drop in the valve by 50 per cent over conventional designs.

The shut-off valves are of the non-rising stem type, and can be repacked under full-flow or no-flow conditions. The disc and stem expansion are of full hexagon form, for positive centering.

Both types of valves are furnished with Duronze stems, standard dimension packings, and easy-to-grasp star handles. Tapered hexagon machining insures a snug-fitting handle.

T Self-Sealing Test Plug These plugs are designed for use when placing tanks, boilers or other pressure vessels under hydrostatic or pneumatic internal pressure tests. The plugs are listed as being available from stock for standard pipe openings from ½ to 2 in. sizes. The plugs require but a

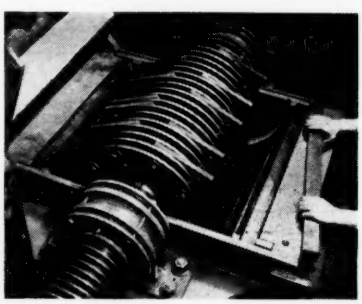
short time to insert and remove; an oversized tapered head on pull rod centers itself against the inside edge of the tank opening and sets up a positive resistance to the pull exerted within the cylinder when forcing the seal against its seat. The plugs are described as adaptable to any type of spudded, flanged or drawn openings, either threaded or plain. They are announced by Mechanical Products Corp.

U Hammer Mill The addition of a new, heavy-duty model hammer mill to the line of 16 standard types has been announced by the Buffalo Hammer Mill Corp.

This new model hammer mill has an overall height of 47 in., base 53 in. by 38 in., charge opening 24 in. by 30 in. and is typical of the other Buffalo Hammer Mills which are used for grinding, pulverizing, crushing, shredding, defiberizing and hashing various materials throughout practically every industry. These mills break up all sizes of material by shattering blows of several batteries of revolving hardened steel hammers at 1000 to 7500 rpm. Material is hit while suspended in mid air to eliminate the generation of heat from friction of rubbing and crushing actions. With the elimination of heat, less power is required and both wear and breakdowns are reduced to a minimum.

This new model is protected from possible damage by a built-in trap which extracts foreign substances after they enter the mills. Material may be discharged two ways,—one is by gravity from the bottom of the machine and the other by conveying pneumatically to a collection system.

Design simplicity and flexibility is made



Repeat Orders PROVE PERFORMANCE

AGAIN in 1944

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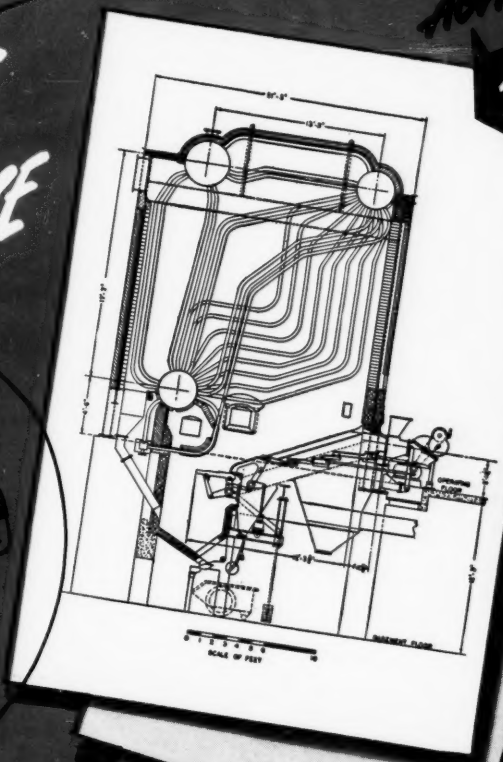
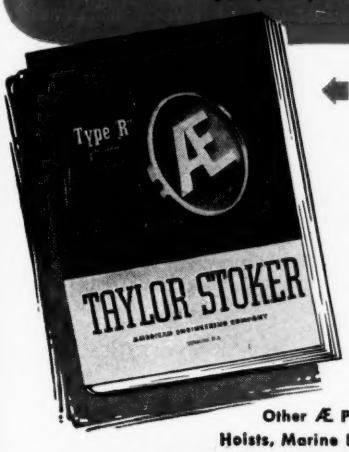


A world famous manufacturer of drugs has completed its 3rd installation of Æ Taylor Stokers with the type R. This 6 retort, 25 tuyere continuous ash discharge stoker develops 50,000 lbs. per hour continuous steaming capacity.



GET THE FACTS ON THE IMPROVED TYPE R

This easy to read 18 page bulletin will quickly bring you up-to-date on the advantages and improvements in stoker operations as provided by the Æ Taylor Stoker. Write for it!

TAYLOR STOKER

AIR-COOLED & WATER-COOLED

The Only Underfeed Stoker with *all* these Features IN COMBINATION!

1. Continuous Self-Sealing Ash Disposal
2. Movable Ash Discharge Plates
3. Smooth-Flow Hydraulic Drive on Rear End
4. Independent Pusher Controls within ⅛ inch
5. Unique Sure-Feed Coal Agitators
6. Silent-Shift Spur Gear Planetary Power Transmission

Other Æ Products: Æ-Perfect Spread Stoker, Lo-Hed Hoists, Marine Deck Auxiliaries, Hele-Shaw Fluid Power.

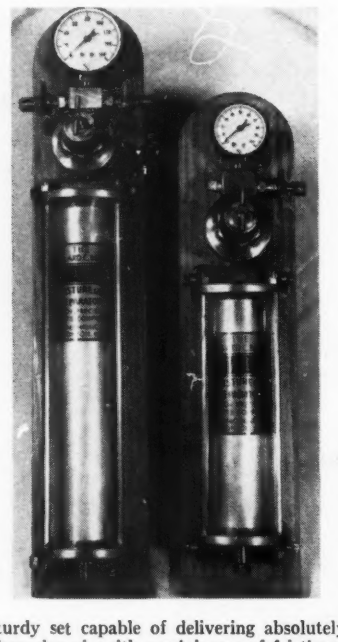
AMERICAN ENGINEERING COMPANY

2408 ARAMINGO AVENUE, PHILADELPHIA 25, PA.

possible by steel plate welded construction which provides special as well as standard models to meet all applications. A complete line of hammers of various thicknesses is available for innumerable requirements. These Buffalo Hammer Mills are available from ½ to 200 hp and speeds of 1000 to 7500 rpm capacities.

V Air Conditioner for Air Lines This new Sta-Dri air conditioning unit is described as capable of screening out rust, scale and dirt from compressed air pipe lines, extracting moisture and oil fumes, regulating air pressures to any desired lower level, gauging final pressure used on dial. These units are announced by Beach Precision Parts Co.

The unit is said to be designed for long, trouble-free operation. It is a rugged,



sturdy set capable of delivering absolutely clean dry air with a minimum of frictional line drop. The Model A-1 Junior Unit will handle approximately 30 cfm of air at 100 psi. The Model A-2 Senior size will handle approximately 65 cfm of air at 100 psi.

The A-1 unit complete with one extra filter is priced at $20.50 fob; the Senior size with 2 extra filters, is priced at $34.50. Both models are panel mounted for convenient installation.

W Inter-Communication System Talk-A-Phone Co. recently "unveiled" it's latest model—The Special DeLuxe line. The chassis marks a notable advancement in electronic design. Incorporating all of the latest features such as "Alnico 5" speakers,

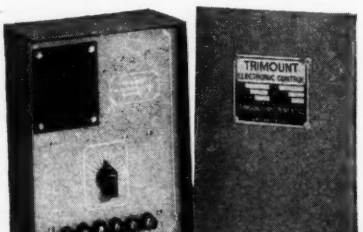
"Insta-Action" selector switch and a powerful high-gain amplifier which delivers the maximum output of brilliant "Voice Range" power, to mention just a few; these new Talk-A-Phone models meet the most exacting demands of efficient operation.

Illustrated is the Special Master Station and Sub-Station in the KR-4010 Special DeLuxe series. This system consists of one master station working with up to a total of ten sub-stations. System may be built progressively beginning with one master station and one sub-station; additional sub-stations can then be added as needed. Master stations can call any one or all sub-stations at will and receive an answer. Sub-stations can also originate calls to master by use of the "Silent Feature." Extreme versatility is stressed in sub-stations which may be installed in any remote spot up to 2500 ft from master station, regardless whether power supply is available there or not. Master station operates on 110-115 v ac or dc.

X Electronic Level Control The Trimount Instrument Co. announces a new Electronic Level Control for controlling high, low, and intermediate levels of liquids and conducting solids in open or closed tanks, vats, bins, pipes, or hoppers.

An electrode installed in the tank or other container actuates a magnetic relay when it comes in contact with the conducting substances. The control unit can be used to actuate solenoid or motor-operated valves, pumps, lights, alarm signals, or other electrical devices.

These units have a new, sensitive conductance control which is adjustable to

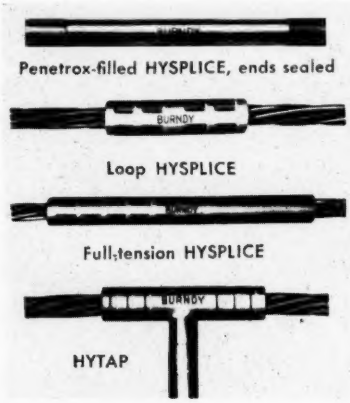


conductivity of a specific substance and is not affected by foam or foreign matter on top of the liquid.

These units are applicable for controlling levels in caustics, acids, paints, food products, milk, water, chemicals, and other substances, and will operate efficiently under extremes of temperature and pressure.

Y Connector Sealing Compound Penetrox, a compound which penetrates oxide on conductor surfaces, and seals them against air and moisture, is featured in the line of Hysplice connectors for overhead high tension lines, developed by Burndy Engineer Co., Inc. Thus it is claimed that highly efficient connections can be made even on oxidized cables.

These Hysplice connectors are readily installed with standard Burndy Hypresses and are available in types for jumper loops and full tension service. Each connector is supplied filled with the Penetrox compound and sealed at each end. The cellulose seals are removed on the job, and the conductors inserted into the Penetrox-filled barrel in the usual manner. When the connector is indented onto the cable with the Hypress, the Penetrox wiping and



sealing compound is forced over and around the individual strands, penetrating the oxide and providing a metal-to-metal connection of high conductivity.

The special dies supplied for the installation of Hysplices and Hytaps make a circular crimp in the connector, and this method produces low resistance connections with high mechanical strength, and rounded edges to prevent corona discharge.

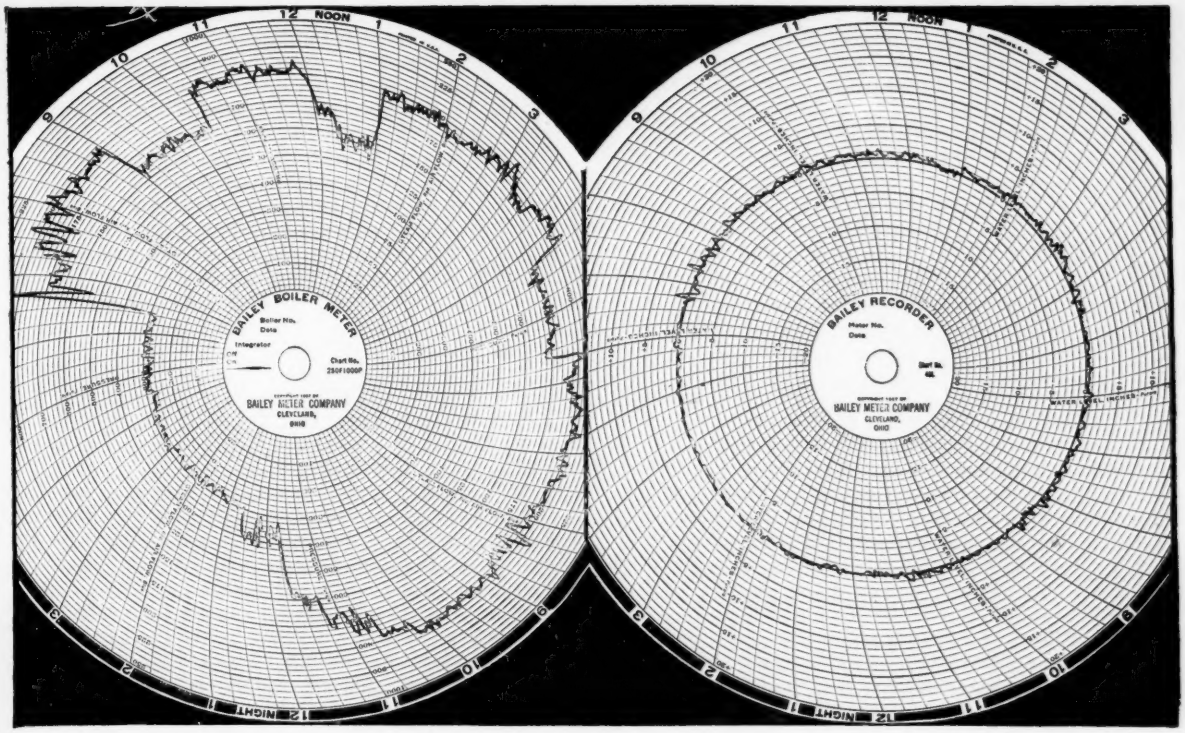
Hysplices and Hytaps are available for use with either aluminum or copper cables; the copper connectors being filled with Penetrox-C and the aluminum connectors with Penetrox-A.

Z Unit Substations High voltage incoming line, transformer, and low voltage feeder sections are combined in one compact assembly in the new All-in-One Unit Substations built by Wagner Electric Corp. Installation is simplified, as the units are delivered ready to connect.

The illustration shows the completely enclosed, streamlined construction of the unit substation with air-cooled transformer for indoor installation. Noflamol (noninflammable liquid-filled) or oil-filled self-cooled transformers are also available.

They are standardized in ratings 100,

150, 200, and 300 kva, 3 phase, 60 cycles. Choice of combinations of different types of transformers and high and low voltage equipment makes them suitable for a wide range of applications.



COPES FLOWMATIC CONTROL
for a 1265-psi, 900-F, C-E Boiler

Over a load range of 110,000 pounds per hour, the water level in this 1265-psi, 900-F Combustion Engineering three-drum boiler is stabilized within plus-or-minus one-half inch by COPES Flowmatic.

The charts tell the story. They were recorded five years after the two-element COPES Flowmatic assumed fully-automatic control of feed input and water level for this high-duty steam generator.

During those five years, no more than routine inspection and care by the boiler-room personnel was needed to keep the COPES operating at peak efficiency. Flowmatic control is dependable.

A performance report on this utility installation is given in 8-page Bulletin 465. There are cross-sections of plant and boiler, photographs of equipment, and charts showing water level control under conditions of constant load, variable loads and emergency operation. Write—your letterhead, please—for a copy of this informative report.

NORTHERN EQUIPMENT COMPANY
172 GROVE DRIVE, ERIE, PENNSYLVANIA
Feed Water Regulators, Pump Governors, Differential Valves, Liquid Level Controls, Reducing Valves and Desuperheaters
BRANCH PLANTS: Canada, England, France
Representatives Everywhere

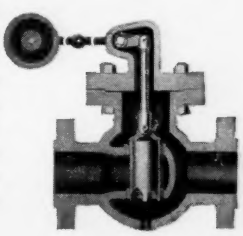
★ GET CLOSER LEVEL CONTROL WITH COPES FLOWMATIC

PUMP GOVERNORS

In most installations, especially where the load conditions do not warrant COPES Flowmatic control, good feed water regulation should begin at the boiler feed pumps. *Dependable* excess water pressure control for your feed system, no matter how simple or how demanding your needs, can be provided by COPES engineers. Write—outlining your operating conditions in detail—for their helpful recommendations.

BALANCED CONTROL VALVES

Many plants have found real savings by paying a few dollars more for COPES Balanced Valves for controlling make-up water to feed water heaters, level in open tanks, evaporator flows and other uses. Control is more accurate with the scientifically-balanced, practically-frictionless COPES. Rugged construction assures long service life.



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YARWAY IMPULSE STEAM TRAP

The Challenge of Affairs

By J. R. TOWNSEND

THE time-honored method of determining future trends is to assume that things will keep to their courses until a serious disruption causes a change in direction. By going backward a few years, it is seen that our people are looking more and more to government for the management of affairs. Recent events reveal that this may become a more and more entrenched habit of our people. All of us are mindful of the tremendous technical advances that have taken place.

It is clear that the role of the politicians is to get people to do things. They collect and add direction to public will. They espouse and sharply define issues and direct public affairs.

The time-honored position of the engineer or technologist is to do the staff work. The politician looks to him for information but distrusts his advice on human affairs. The physical laws with which the engineer is most familiar are constant. The politician regards the engineer as living in an ivory tower and feels that the engineer's standards are too rigid. The rules that are used in human affairs must be elastic and adjustable to the circumstance.

The engineer, on the other hand, frequently has contempt for the politician. This contempt leads to distrust and avoidance. These, of course, are symptoms of lack of comprehension and appreciation of what the politician can do in the practical sense of getting people to work.

Out of this emerges the duty of every engineer to make his contribution to political thought. The ASTM, because of the nature of its work, is particularly fitted to spearhead and show leadership in its contact with the Government on technical matters. The engineer's most direct contact with political thought is through his client or his management and his membership in technical societies. He should think of management problems, public relations, developments in political and physical science and use every opportunity to apply his brains to the management of human affairs at his own level.

There is more here than first meets the eye. The present situation in the world presents a soul-searching problem. We are overcome with *fear* and its partner, *distrust*. We feel insecure socially, politically, and economically. Each day there are revealed in the press new and more fearsome weapons. Can we trust the present leaders of men with such inexorable forces? In the field of commerce our economy is threatened by pressure groups, led by dynamic but selfish men. Despite arresting protests, these leaders tend to deprive us of choice. No opportunity is presented for consultation and negotiation, but instead we have the unpleasant spectacle of unrestrained human nature. Yet, the World's work requires that men be organized, marshalled, directed, and led if our civilization is to succeed.

I am not suggesting here that these problems be turned over to the engineer. We engineers are a modest lot. Experience has chastened and taught us through our many mistakes that trouble is to be foreseen and that human reform is slow at best. But material civilization is moving on. There are many new things to be assessed and weighed. No longer can we solve our engineering problems with Newtonian mechanics and elementary chemistry. On the surface it seems fashionable for our young engineers to be concerned with electronics, plastics, supersonics, atomic physics, and the like. An engineer cannot be a master of all of these fields of activity. However, he must acquire knowledge of their possibilities and limitations and understand how they may be adapted and applied to human use.

Please do not misunderstand me. It is not necessary for an engineer to be skilled in every subject under the sun. Capacity will automatically limit this for the individual. I do not feel either that the engineer should follow all of the sociological and economic fads of the present. A well-balanced ration of thinking, as applied to human needs, will take care of this.

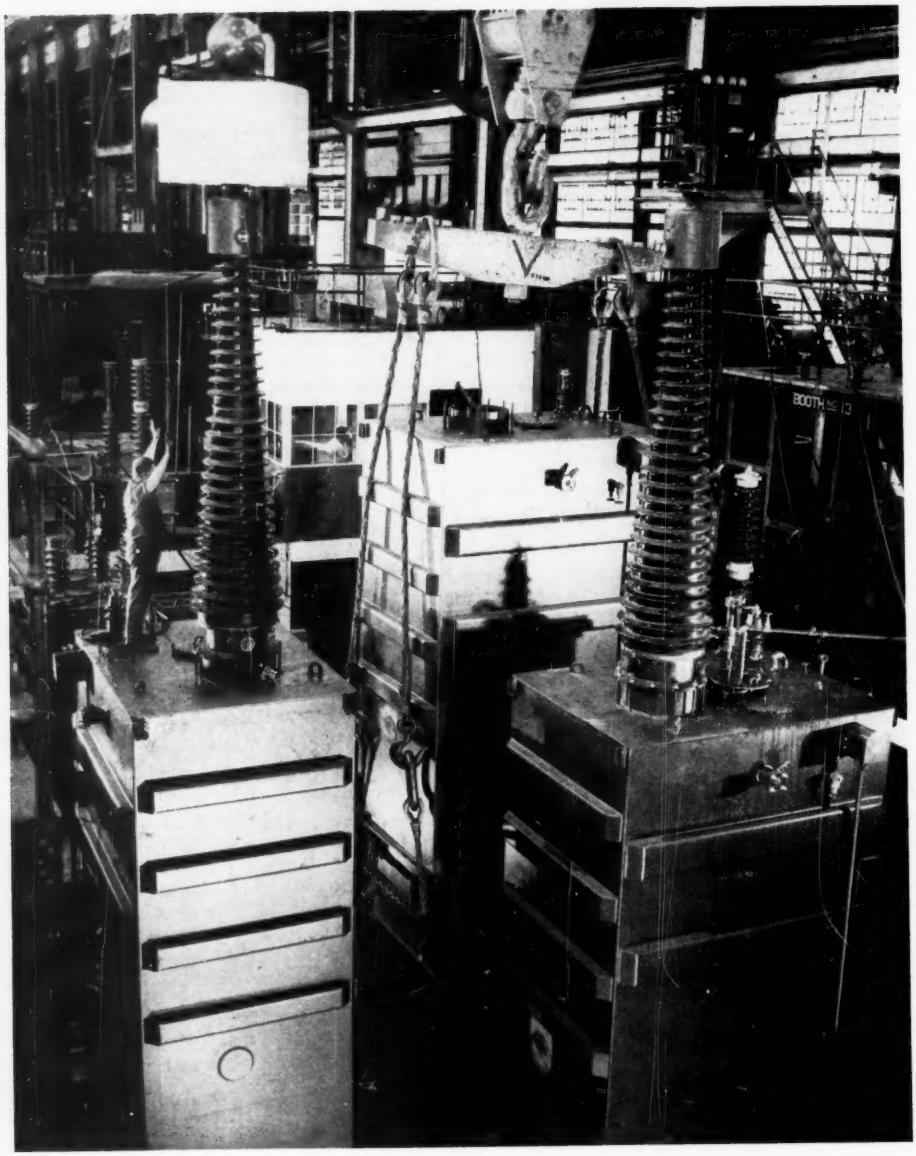
The way of the legislator and public servant has not been made any smoother by recent events either. It has long been the tradition in America that social and economic reform can be brought about by political reform. This has involved the time-honored process of voting out the "ins." Alas, this will provide little in the solution of our problems. Knowledge of political philosophy alone and its practical application, while an important factor in the field of affairs, is not sufficient and cannot solve such problems as now beset all of us. Science and technology have provided us with potent things that must be directed for the benefit of *all human kind*. We thus have a triumvirate: *Government, business,* and a third party who is a master of technology. I submit that this third party should be the engineer.

It is folly to suggest that only the technical man should manage or direct public affairs. Human affairs must be settled by compromise and adjustment. The answer is never a rigorous one except in the broad principles based on the proper human selection of values. The rigorous method of the scientist will not do. On the other hand, the legislator does not understand or appreciate the nature of modern industrial processes or developments. He needs the help of the technologist to reveal the facts so that he may assess the human values.

Reinforcing the appeal of Hon. Carl Hinshaw, in the December issue, for engineers to participate more effectively in public life, here is another forceful discussion of the subject from the point of view of the engineer himself. It comes from John Robert Townsend, president of ASTM in 1945-1946; and is taken from his presidential address published in the ASTM Bulletin.

Mr. Townsend is Materials Engineer, Bell Telephone Laboratories, Inc., New York. He was born in Baltimore in 1895, received his education at Baltimore City College and Brooklyn Polytechnic Institute and after serving in the U. S. Army Ordnance Department, became a member of the technical staff of Western Electric Co. in 1919. In 1925 he became materials standards engineer for the Bell Telephone Laboratories and in 1945 became materials engineer. He is author of many technical papers and addresses on fatigue, test methods, design of telephone apparatus, gaging, standardization and the like. He is a member of ASME, AWS Standards Council ASA, was awarded the Dudley Medal of ASTM in 1930, and was president ASTM, 1945-1946.

During the war he worked on many problems in connection with the Armed Services, the OSRD, the WPB and others. He was sent to Europe in the spring of 1945 in connection with the work of the Foreign Economic Administration. He speaks with authority, therefore, on the ways in which the engineer can meet the challenge of public affairs.



For Tomorrow's Transmission Lines

Three transformers, built to step up electric current to as much as 500,000 volts—nearly 75 per cent greater voltage than that now carried by any transmission line—are shown in the test pit of Westinghouse Electric Corporation's Transformer Division. These transformers, each 37 feet high and with extra heavy insulation were built for the American Gas & Electric Service Corporation's experimental line near Brilliant, Ohio. In this work two 3-phase power lines are being erected, 1½ miles long, so designed and equipped that thorough studies can be made of the important factors that control the economic application of transmission line voltages higher than the 287 kv present maximum voltage. Investigations will be centered about corona loss, radio interference and insulation coordination at high voltages. Tests will be made at voltages from 264 to 500 kv. Such investigations are expected to provide essential data for the design of transmission lines and terminal equipment for the economic transmission of electric power at these high voltages in the relatively near future

Trends and Developments in the Power Industry

Despite excellent record made by the Power Industry during the war, it is left with only meager reserves. Considerable new capacity will be needed to meet steadily increasing loads. War developments provide many new elements in design and the developments in the use of atomic energy may change the course of progress in years to come. Many new and unusual electrical developments provide an interesting field for study and speculation as to their possible future use in the electric power industry

AS WE ENTER a new year it is good for us to pause and take stock —inventory, they call it these days— of what we have and where we are heading. The war has been over, now for a year and a half, but the world is still far from settled and many of us wonder whether we will ever again return to what we used to call "normal" times.

Those of us concerned with the field of power engineering have less to worry about than those associated with other more competitive industries. Power happens to be the common denominator of all industries and it follows that if industry prospers, the power industry also will prosper. As far as the war is concerned, the power industry made an excellent record. With only 25 per cent increase in generating capacity during the war, the national power plant was able to generate almost 75 per cent more power. In 1939, the total installed generating capacity in the power plants of this country was about 50 million kw. Of this some 39 million kw was in utility plants and 11 million in industrial power plants. During 1939 this total plant generated 163 billion kwh.

By the end of 1944, the total generating capacity of the nation reached 62 million kw, 49 million of which was installed in central stations and 13 million in industrial power plants. This same plant, however, in that year generated almost 280 billion kwh, almost 75 per cent more than in 1939. This remarkable accomplishment was the result of, (1) high load factor due to 24 hr a day operation of industrial plants, (2) reducing transmission losses, (3) slashing margins of reserve capacity, (4) wartime "pooling" and (5) reduction of peak load by the use of war time.

While there has been some new power plant construction since VJ Day, it has not been large and while our total capacity is adequate for immediate demands, it leaves us with little excess capacity to meet the steadily growing peacetime demands. After VJ Day there was a considerable reduction in the national load from its war time level but since July of last year (1946) the output of the central stations has been growing steadily. At the present time the output is higher than at any similar time during the war and the curve is mounting steadily upward.

This means that new generating capacity will have to be added to meet expected greater demands and to restore the margins of reserve capacity to normal levels.

The need for new generating capacity brings with it problems in design, in economics and in the use and selection of fuels. Technological developments during the war brought forth many new and novel ideas, many of which may lend themselves to future power developments but at the present time it is not certain as to what course these developments will take. The gas turbine, for example, has undergone considerable development during the war years and it is quite possible that it will enter into the field of electric power production to an increasing extent in the near future but the designer confronted with the task of designing a plant for operation next year still has to confine his ideas largely to the use of the steam turbine.

The question of fuels is important. Coal and oil, today have uses other than as fuel; they are the raw material for many valuable products and the time may be approaching when these commodities will be too valuable to burn as fuels.

A new element in the fuel picture is the question of atomic power. There is little doubt in the minds of those who know most about atomic energy that it will not be long before we will produce electric power from this energy source. At present, the economics of an atomic power plant are at a disadvantage compared to a coal or oil burning plant but even now, at this very early stage, the difference between the cost of producing power from nuclear energy and from coal is comparatively small and it seems quite possible that in the not too far distant future, this small difference will be wiped out. The use of atomic energy will not reduce the cost of electric power a great deal, very little in fact, but it provides us with a greatly extended energy source. Uranium is not a rare element as some have supposed. It is commoner in the earth's crust than silver, antimony and mercury combined and while it is, and probably will be, costly to extract its intrinsic energy value is so great that refining costs, even in the case of low grade ores, can be sustained. Allowing refining expenses of several dollars per gram it is probable that fissionable material could be extracted economically from granite or other low-grade large volume sources. Thus, it appears that for the first time in history we can look forward to an available source of energy that will carry us through a great many centuries to come.

At the present time considerable research and development is going on in the utilization of nuclear energy for power purposes. An experimental plant is being built at the Clinton Engineer Works at Oak Ridge, Tenn. and the General Electric Co. also is making plans for plants in the vicinity of Schenectady.

The war brought out a number of interesting possibilities in connection with the burning of fuels. The Germans, for example, made considerable use of hydrogen peroxide, both in powering their V-2 rockets and in their long range submarines. By the use of hydrogen peroxide it was possible to build power plants in submarines that did not require a supply of air for combustion and as a consequence these submarines could remain below the surface of the water for long periods. While this use of hydrogen peroxide was developed for highly specialized purposes, it is possible it may have applications in ordinary power practice.

The use of oxygen for combustion also has interesting possibilities. The idea of using pure oxygen for combustion is not new but as long as oxygen sold at from 12 to 15 cents per thousand cubic feet it could not compete with air for combustion purposes. Recently, however, as a by-product of other proc-

esses, it appears that oxygen can be produced at a cost of less than five cents per thousand cubic feet and at this price a number of things become possible. It may make possible the production of gasoline from natural gas and from coal. On the basis of estimates made recently, 6-cent gasoline from $2.00 per ton coal is not more than 2 or 3 years off.

In the field of electricity there have been many new and startling developments during the last few years which may have a decided influence in the power industry. Most of these developments lie in the field of electronics but it is evident that electronics is rapidly becoming a definite part of the heavy power field. Today, we have in operation electron-tube frequency converters of 20,000 kw capacity and more and more electron tube rectifiers and inverters are taking the place of rotating equipment.

Whether radar will be of any use in the heavy power industry remains to be seen but it is evident that certain radar techniques, certain of the equipment used in radar work, will be used. The cavity magnetron for example is capable of enormously high power outputs under certain conditions and it is quite possible that such devices will find application in industry. A cavity magnetron about ten inches high, for example, is capable of pulse outputs of a thousand kilowatts or more.

A study of German methods during the war shows that they seriously considered the possibility of high voltage direct current transmission lines of 500,000 v or more. At least one company in this country is experimenting with such direct current high voltage transmission. The idea, of course, is not new but today we are closer to the actual construction of such lines than at any time in the past. Today we have the high power, high voltage electron tubes that would have to be used in such systems.

The extension of the useful field of radio waves to the very short wavelengths has made the optical properties of such waves increasingly apparent and the effective use of this optical nature has been made in the use of concave parabolic mirrors as radio antennas. More recently, however, metal lenses have been made which are capable of focusing radio waves in the same way that visible light waves are focused by glass lenses. Such lenses give great directivity to radio waves and make it possible to direct practically all of the power fed into an antenna in one very narrow beam. Some of these lens type radiators have exhibited a power gain of as much as 12,000 over an isotropic radiator. At approximately 1.8 degrees off the beam, the power gain of such an antenna drops off to one-one hundredth of its maximum value. The reason for mentioning these antennas here is that they make possible the wireless transmission of power some time in the distant future.

While there have been no startlingly new developments in the field of heavy power generation and transmission, development has continued along lines laid down in previous years. There had been a greater trend toward the use of hydrogen cooling in the design of large electric generators and there is a tendency toward the use of higher hydrogen pressures.

Switchgear has been improved to the point where alternating current circuits of almost any capacity can be interrupted. Of interest in this connection are the short circuit test made at Grand Coulee. In these tests on the 230 kv system, single phase faults with equivalent short circuit currents of 4,370,000 kva were cleared with no apparent effort by the oil circuit breaker. These are believed to be the heaviest short circuits ever interrupted on any power system in the world.

Power Plant Design

DURING THE past year or two, the trends already underway just before and during the war in overall plant design have continued about as predicted. In the large central stations, simplification of design and equipment and more extensive use of automatic controls seem to be the two factors of most influence in keeping costs down. Modernization may be a problem in some existing stations. Others have reached the limit of their planned capacity as determined by condensing water supply and system factors. Geographical redistribution of heavy load centers during the war and further redistribution of load, as war plants were shut down or reconverted to civilian production, will affect materially the location and capacity of new plants required on a given power distribution system during the next few years.

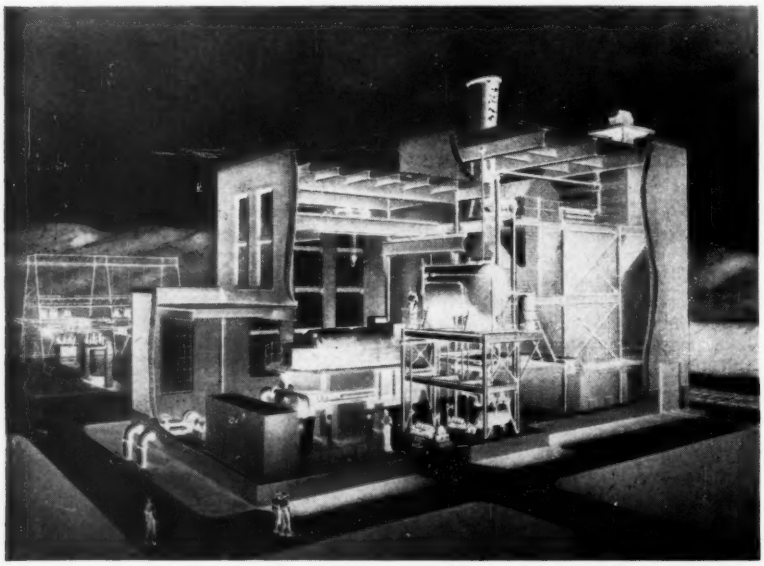


Fig. 1. Cut-away view of a 5000-kw steam power plant, of a standard design easily adaptable to wide variety of foreign and domestic conditions, as proposed by Westinghouse International and designed by Ebasco

Fuel availability may also have an important influence, if coal costs rise to the point of bringing other fuels into competitive range. Many plants have been designed to burn either coal or oil, to take advantage of competitive price variations and to protect against the ever-increasing threat of coal supply stoppages due to strikes. Where such design is carried out in the initial plans, little trouble is encountered. Some stations on the east coast, designed for burning two fuels, ran into difficulties during the war when oil was commandeered for military purposes and then coal was rationed. This, however, was a procurement rather than a technical problem.

Other stations, originally designed to burn oil only, had to be converted to coal in the early stages of the war and a number of consulting engineers and manufacturers were forced to spend considerable effort in doing this.

First 1000-F Plant Built

The upward trending curve of steam temperatures has finally hit the 1000 F mark, despite considerable controversy about the effects of graphitization and

the costs of constructing such plants to avoid it.

For some time it has been reported that the superheaters installed in several refineries during the war for supplying low-pressure process steam at 1400 F had been operating satisfactorily. As a result of this and the work on graphitization done by metallurgists and power engineers during the past two years, it has now become quite the thing for some engineers to say confidently that 1000 F steam temperature is conservative.

Steam turbine progress continues mostly along the lines previously laid down before the war. Refinement of details, improved details of governors and lubricating oil systems, standardization of unit sizes, more streamlining of turbine exteriors are the important trends in this field.

Because of the interest of a few of the large utilities and some industrial plants in the subject of separate auxiliary generators to hold auxiliaries on the line in case of electrical disturbances, there has been considerable discussion of this subject.

The Package Plant Idea

The trend toward the package idea was strongly encouraged during the war by the necessity for building in this country a number of power plants that could be assembled in complete operating units; shipped and handled by foreign railways, trucks or other transportation; quickly and simply erected; capable of burning relatively low-grade fuels found abroad, including wood; and utilizing condenser circulating and boiler feedwater of very poor characteristics.

Such packaged types of plants were built in capacities from 500 kw to 8000 or 10,000 kw and were used to supply power to areas occupied by our advancing armies or, in other cases, to supply power to non-war areas for industrial and military production. Some complete plants were mounted on railway cars and known as power trains.

Several large plants of 30,000 kw capacity each were installed in barges, aided our own power systems in handling war-time loads and were later sailed to European waters where they generated power for liberated areas. Mobile power plants may have postwar applications in emergencies, or for special load conditions.

The whole package plant idea may lead to some interesting developments in the design of small central stations and industrial power plants to meet the postwar demands for rehabilitation of our power facilities. The compactness of some of the package plants and units may permit their use in industry without occupying great space. Their cleanliness may permit installation right in a factory building, as was done in some war plants.

The Standard Power Plant

Success of the package plant leads further to a simplified and standardized power plant, somewhat as shown in Fig. 1. This is designed to be standard not in the sense that it must be built to a rigid design, but rather that its general characteristics, with minor revisions, can be adapted to a wide range of fuels, water, location, weather and operating conditions. It is a unit plant—one boiler per turbine—designed for high overall operating economy, although additional units such as boilers can be easily added to meet special requirements. The idea of non-duplication of equipment so far as possible has been utilized.

Fig. 2. Typical of American radar equipment which did so much to smash German and Japanese armed might is this radar "Beach Umbrella." This device is an antenna used as a reflector in sending out shortwave radio pulses and as a receiver to catch the wave echoes reflected by enemy targets. This type of equipment may some day play an important part in electrical developments

Fuel Burning and Coal Handling

New methods of preparing and burning fuels will affect future plant designs. The spreader stoker is finding wide application for moderate capacities. New methods of burning coal in suspension, as in the cyclone burner, have proved successful and may materially alter the burning of large amounts of fuel in large boilers. The coal atomizer for pulverizing coal without mechanical pulverization is attracting attention, will be used in the coal-burning gas turbine locomotive and the manufactured gas industry.

Coal handing problems have received much attention during the war and many of the power plant designer's difficulties in the overall design of a plant are connected with them. Outdoor storage of coal has been effectively solved and, by methods now well tested by several years use, it is possible to store coal in outdoor piles without danger of fire or undue deterioration, by proper packing, rolling and sealing of the pile surface.

However, during the war, because of difficulties in mining and transportation, troubles with wet and frozen coal were widespread, increasing handling costs tremendously. Coals of lower grades, not adequately prepared, had to be used because the best fuels had to be given military priorities. As a result, handling of wet coal, clogging of bunkers and chutes, drying of coal in cars, etc., received much attention.

Radiant heating pits for coal cars were successful in many cases. This has led to the suggestion that for large

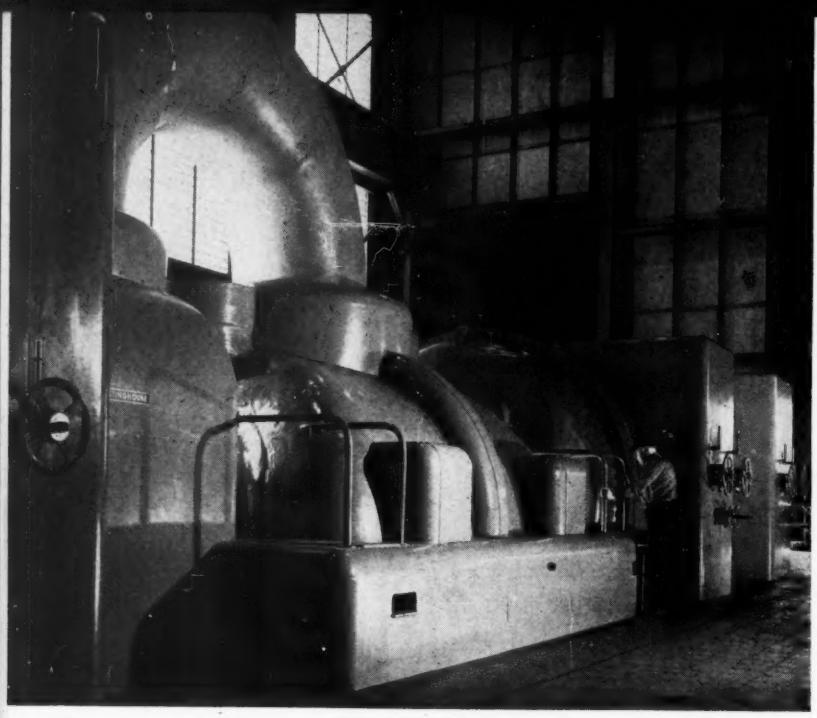


Fig. 3. View of the Westinghouse 80,000-kw turbine generator, Unit No. 7, recently installed at Springdale Power Station

plants a development of high frequency radiation heating be used on entire coal cars when frozen. Much has been learned about design of coal chutes and hoppers to produce good coal flow. New types of conveyor such as the *en-masse* or continuous flow unit and the side-car carrier type have had wider applications but all the standard types have been improved and refined. In this field, too, the package idea bears fruit in a design of a complete coal handling assembly, the components of which, by rearrangement and minor adaptations, can be fitted to a very wide variety of individual plant conditions.

Fuel oil and natural or manufactured gas fuels are finding increasing use as industrial fuels, particularly in view of the competitive position into which coal is being forced by coal strikes and stoppages and by the lower quality of much available coal.

Combustion practices, prices of fuel oil, prices of gasoline from coal, production of gasoline from natural gas, production of low-cost oxygen for use in synthetic gasoline processes and possible coal gasification at the mine, supplying of oxygen for fuel burning from hydrogen peroxide, use of nuclear fission to supply energy in place of conventional fuels—all these will influence the design of the power plant for private utility, municipal or federal utility, or industry in the near future.

The gas turbine is now making its bid for recognition. It is not going to supplant the steam plant or the Diesel plant but will in most cases supplement them.

But one of its biggest fields will be in cases where power is needed but no water at all is available, for gas turbine plants of good efficiency can be built at costs similar to those of steam plants but without requiring any water in the cycle. For the same reason the gas turbine may also have important applications where atomic fuels are used.

There will be a growing interest in the future in recovering heat from exothermic reactions in industrial processes, that is, those reactions that generate large quantities of heat energy which can be removed and utilized. In the Houdry process, large quantities of heat are removed by transferring it to a molten salt, which is then circulated through a heat exchanger generating large quantities of high-pressure and high temperature steam. Part of this steam is supplied to turbines generating power for the process and the remainder is used in the process in various ways. Again, in the synthesizing of gasoline from natural gas, large amounts of steam for driving turbines and for reuse in the process are generated by heat developed in the process reactions.

Power Plant Equipment And Operation

TRENDS IN BOILERS continue toward objectives of high reliability and wide range. The principal problem today is to make up the back log of the demand resulting from 16 years of depression, partial recovery and war.

Capacities of boilers in recent and projected central stations range mostly between 100,000 lb per hr and 400,000 lb per hr and those for industry go to about 300,000 lb per hr, the average range being 50,000 to 200,000 lb per hr.

Pressures and temperatures of most recent and proposed central station boilers are 800 to 900 psi, 900 to 925 F. The 1500-lb units are numerically in the minority in the new construction. Many of the smaller units are designed for 400 to 600 psi but there are several of around 10,000 kw designed for 900 psi and one for 1500 psi. The trend towards one boiler per turbine is now strongly established.

A few extremely large boilers have been installed during the war. For example, there is one unit capable of 1,000,000 lb per hr, designed for steam conditions of 1600 psi 950 F. Another unit recently described in these pages is for 800,000 lb per hr at 1325 psi 925 F. A recent new installation, however, employs two 850,000 lb per hr 850 psi 900 F boilers to serve 150,000-kw turbine generator. The recent unit for 1000 F total steam temperature is relatively small—310,000 lb per hr, 1350 psi.

In industrial boilers, package units range in capacity from 200 or 300 lb per hr up to about 18,000 lb per hr in the fire tube types, up to about 30,000 lb per hr for water-tube types. Standard water tube types range up to 300,000 lb per hr determined largely by the demand for industrial steam. Steam pressures are going up in industrial plants, especially as electric-steam balances improve and many units are planned for 400 to 600 psi. Average industrial steam temperatures are around 750 F for larger plants, from 450 to 750 for smaller plants, again determined by industrial requirements.

In industrial boilers, a new idea of double circulation boiler is being introduced, the primary circulation being the high duty radiant sections which are blown down continuously into the lower duty convection section, the latter capable of operating at higher concentration. The object is to reduce blowdown

heat losses and there are other advantages.

Steam Temperature Control

Need for accurate steam temperature control in boilers generating at 900 F and above is met by combinations of radiant and convection type superheaters, attemperators, de-superheaters, gas by-pass dampers and the like. In one 1000 F boiler now being built, radiant and convection type superheaters are installed, with a condenser type exchanger under automatic control for positive control of final temperature.

In another recent unit for 900 psi 900 F, superheat control is provided by submerged attemperators and connected between two sections of the superheater. The attemperator tubes are installed in a lower water drum of the boiler and cooled by the boiler circulation water.

Another method of superheat control, coupled with slag control and other factors over a wide load range, was recently installed in a new central station. It is the use of tilting pulverized coal burners as shown in Fig. 10. Another method is the use of twin furnaces, one of which is a separately fired superheater furnace, containing both radiant and convection superheater surface.

Piping

As noted above, graphitization of steel pipe has been intensively studied, improved types of piping developed but for those who must continue to operate carbon-moly steel pipe, the only thing so far definitely recommended is to develop metals that will withstand the high temperatures, use them in existing installations where possible and specify them in new installations.

Welding of piping and fittings, as well as of all types of equipment received great impetus during the war and many of the procedures developed there can be very useful in the future.

Of particular interest to industry are the methods of fabricating and using glass piping developed during the war. These methods, among which are reported to be a welding process for glass pipe, will soon be "de-classified" and made public.

Electronic Controls

Among the interesting developments in some recent plants is the use of electronic types of combustion control systems. An application of electron tube principles and methods is in the combustion control of two new 40,000 lb per hr boilers as described in detail in the November issue. Another recent application of electrical control and metering is on a new 100,000 kw generating unit for which steam is supplied by two 475,000 lb per hr, 1375 psi, 725 F pulverized coal fired boilers. Combustion controls for these units are of the all electric type in which a master controller responding to throttle steam pressure varies the loading voltage on solenoids of the draft fan and fuel control regulators. Vacuum tube circuits amplify primary contact values to operate motor-driven actuators. On main steam and water flow meters, electronic telemetering to recorders and integrators in the central control panel is employed. A recording oxygen meter, using the catalytic combustion principle, is also employed.

Boiler Circulation

Boiler circulation has received considerable attention during recent years. The forced circulation principle for boilers, as contrasted with the natural circulation principle, has been much studied by European designers and widely used there, notably in the Velox, LaMont, Benson, Loeffler, Ramsin and other types. In this country, however, much more attention has been devoted to the natural circulation boiler. For all practical purposes, the problems of natural circulation in boilers at operating conditions up to 2500 psi and 950 F have been successfully solved and most American boilers employ this design.

There are a few exceptions, however. The 2000-psi forced circulation steam generating unit at Somerset Station is one. Another is the forced circulation unit at Kobuta. Small forced-circulation once-through boilers, as produced by Besler, have been used where relatively small quantities of steam—up to 1500 lb per hr per unit section—are required at pressures up to 2000 psi and temperatures up to 900 F for testing and for special industrial applications.

Chemical Cleaning

Chemical cleaning of boilers and condensers has been receiving considerable attention during the war, first because of its possibilities in reducing outage time of equipment when time was vital, second because in many cases it greatly reduced cleaning costs. This trend will doubtless continue, for it has demon-

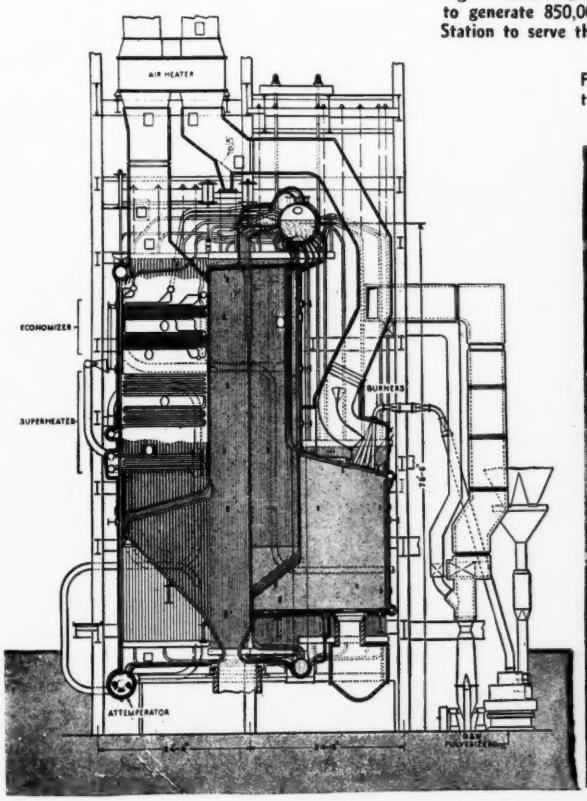
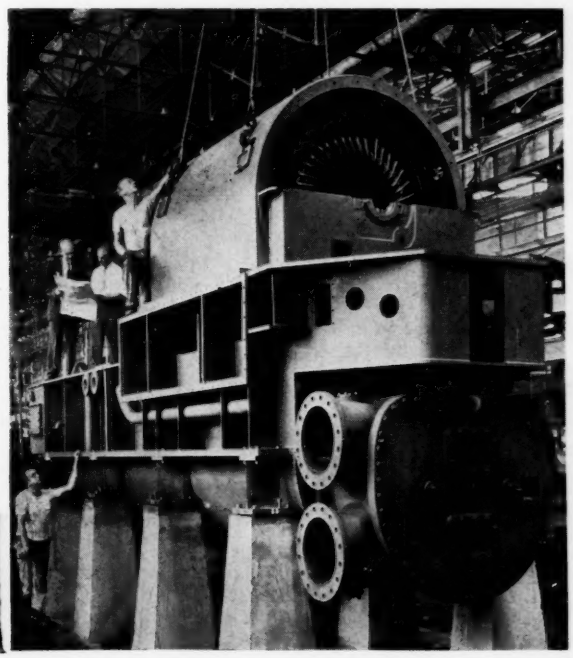


Fig. 4 (left). Cross-section of one of two B & W open-pass boilers, each designed to generate 850,000-lb per hr. of 850-psi 900-F steam, being installed at Southwark Station to serve the initial 150,000-kw turbine generator. Note attemperator installed in bottom of boiler drum

Fig. 5 (below). By mounting turbine-generator on condenser shell thus, compact integrated unit is developed for use in the standard plant of Fig. 1



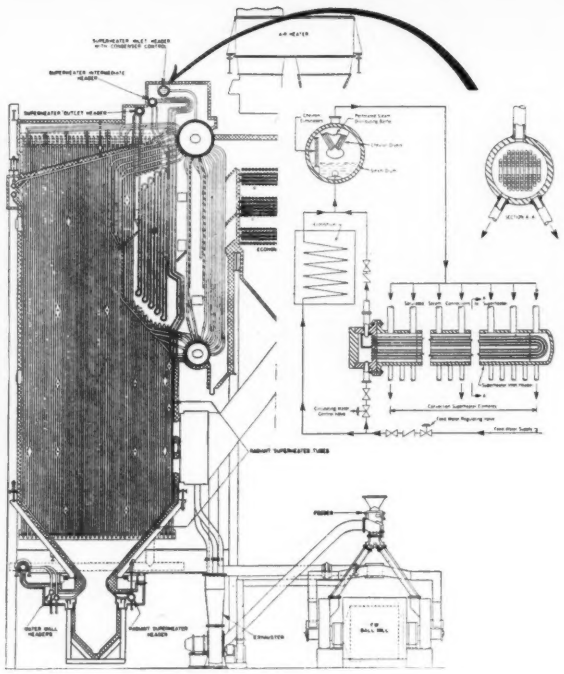


Fig. 6. Inset shows condenser type control of total steam temperature in Foster-Wheeler 310,000-lb per hr, 1350-psi 1000-F steam generator unit, first for this temperature, installed at Missouri Avenue Station

strated its usefulness. It is not a new idea, having been tried at various times for 50 yr. But in reviving it in recent years, use has been made of new methods of determining the characteristics of the dirt to be cleaned, using the proper solvents to fit the conditions and, of extreme importance, use of the proper inhibitors and methods of controlling the chemical cleaning process.

There have been some difficulties in using chemical cleaning. It some cases, corrosion in tubes and drums, found after cleaning, has been attributed to the chemicals. Studies are still continuing on the effects on parts of repeated chemical cleaning. In at least one case, a severe explosion occurred in a turbine and condenser, caused by the ignition of gas apparently generated during the condenser cleaning with acid. Despite such difficulties, the chemical cleaning technique is making progress, is being studied carefully and promises to be an important maintenance technique in the future.

The problem of atmospheric pollution from smoke and gases discharged from power plants has led to much study of fuel-burning methods to prevent emission and of dust-collecting devices to remove the dirt from the flue gas. New forms of mechanical dust collectors have been developed, and there is now a combination mechanical-electrical collector available for which very high dust-collecting efficiency is claimed.

For cleaning of boiler heating surfaces, the air-puff soot blower has been introduced and has been installed in a number of recent stations, particularly those operating at high pressure. This system is often combined with completely automatic sequential control of the blowing. The automatic feature may be used, of course, with either steam or air blowing.

The entire subject of cleaning of heating surfaces and prevention of stack emissions often goes right back to the way the fuel is burned in the first place. Suppliers of fuel, designers of furnaces and fuel burning equipment and gas cleaning equipment, combustion engineers—all are working on the problem. There is an increasing public clamor for prevention of atmospheric pollution and the steam generation and fuel burning sections of the power industry will be forced to satisfy that demand.

Steam Turbines

During the war, much of the steam turbine capacity constructed was allocated for marine propulsion, requiring many geared units of relatively small capacity.

Despite the war production, turbine manufacturers were still able to produce about 11,000,000 kw of stationary utility and industrial capacity.

Several of the generating units installed during the past few years have been of comparatively large size—for example, the Southwark 145,000-kw unit and the 100,000-kw unit at the Tidd Station—and several other large units are planned, such as the two 100,000-kw units for Sewaren Station. The new Springdale unit is 80,000 kw at unity power factor or 65,000 at 0.8 power factor. One unit is now being designed for 145,000 kw capacity to operate at 2000 psi, 1050 F with reheat to 1000 F. It will be cross-compound with double-flow exhaust and gives promise of being the highest efficiency unit in the country.

However, a large number of recent central station units, both those completed and those proposed for the next year or so, fall in the capacity range between 20,000 and 30,000 kw capacity, another large number range between 40,000 and 50,000 kw capacity, while most of the municipal steam plants recently erected and planned range from 2000 to 10,000 kw capacity. The City of Glendale, California plans a 20,000 kw unit for 1947 installation while Richland Center is to have a 10,000 kw unit.

Developments in the large units seem to be primarily in design of details for reliability, safety and operation effectiveness. The 3600-rpm turbine is becoming standard for units up to about 65,000 kw capacity.

Before the war, many new topping turbines were installed. The reasons for using them are not now so urgent, and among projected units there are very few; and many of those are industrial units.

Turbine governor design has received considerable attention recently and some improved types of governors are appearing on new machines.

Turbine lubrication and lubricating oil practice have been greatly improved by turbine designers, operators and lubricating oil suppliers. Methods have been worked out for testing lubricating oil by operators and laboratories.

Precautions against oil fire have been

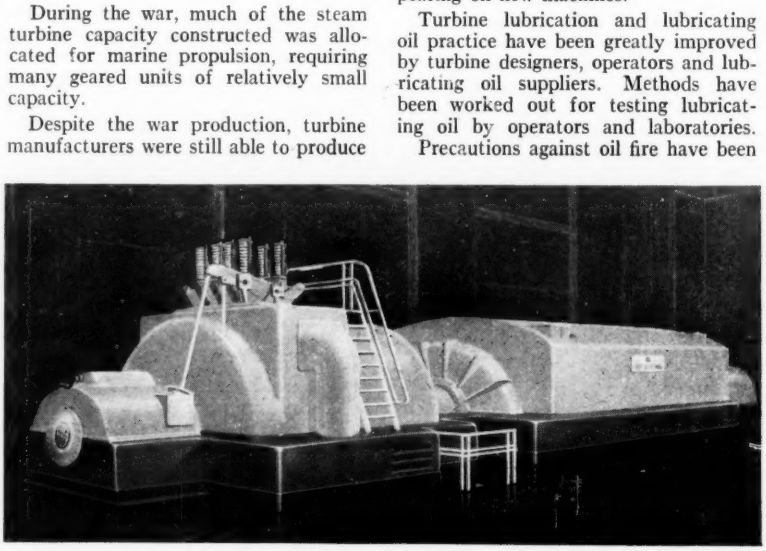


Fig. 7. The 65,000-kw General Electric topping turbine-generator recently installed at Hell Gate Station

well worked out such as design of piping, location of high-temperature piping and valves so that oil cannot reach them, oil tanks below the floor and other details.

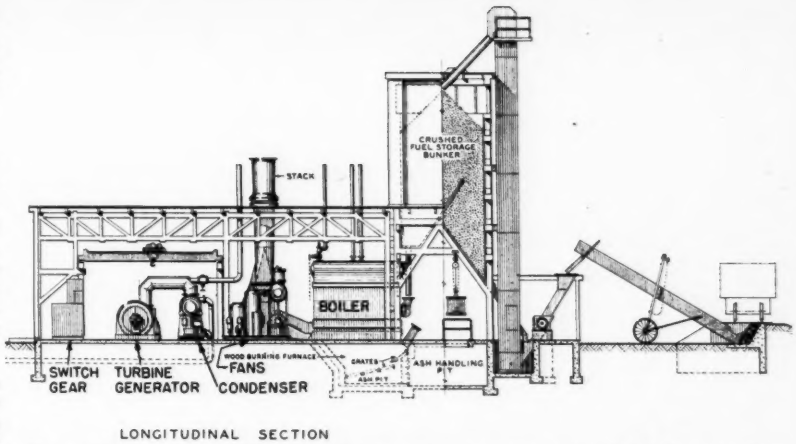
Water Problems

Water conditioning continues to be of the highest importance for power plant and industrial water supplies. Changing water tables, water pollution by waste products, organic growths in water passages, various contaminants originally in the water, the constituents carried in solution in the water itself—all these produce problems for any plant in which water is used.

Supplementing the well-tried systems of zeolite, hot and cold process lime-soda softening and others, new methods for water treatment are constantly being investigated for plants with high make-up. The de-mineralizing process for water treatment is being used in some new plants. There is a new sludge-blanket hot process. There are new methods of treating water by conditioned slurry to accelerate physical and chemical reactions and reduce retention time.

The evaporator, the feedwater heater, the deaerating heater and other water loop components have all benefited by developments in heating surfaces, tube bundle construction, details of shell construction and control.

A new-war-time development, compression distillation, for producing pure water from sea water, was used on board ship and in foreign installtions. It may have important industrial uses. In this process, vapor from a still is compressed by a steam compressor, raising the vapor temperature so it can boil the raw water. The apparatus needs no cooling water and it is claimed has an economy equivalent to 15 or more effects. Compressor drive may be a motor or an internal combustion engine. It will produce about 175 lb of distilled water for every pound of fuel consumed.



LONGITUDINAL SECTION

Fig. 8. Cross-section of a 1000-kw packaged steam power plant, designed by Loftus, showing unit assemblies of prefabricated equipment. Includes induced draft cooling water tower assembly not shown

The Gas Turbine Power Plant

THE GAS TURBINE is already here. In the oil industry, in this country, 26 gas turbine plants are now in operation as part of the Houdry process, supplying in addition some very low-cost by-product electric power. The gas turbine is definitely here in the aviation field, in the form of the supercharger and the jet engine. The U. S. Navy has a successful 3500-hp gas turbine test installation designed for operation at 1500 F initial gas temperature and already operated successfully at 1350 F. This is now installed on shore and is being studied for adaptation to ship propulsion, where it will save space and eliminate the water problem. Another unit, slightly smaller, for marine use, has been built and tested at its manufacturer's plant.

Two complete 3500-hp gas turbine plants have been ordered and are being built for the gas turbine locomotive. These are to burn pulverized coal. Another 2000-hp gas turbine plant for locomotive use, burning oil, has been built and is now being tested by its manufacturer.

The chances are very good that in about 20 months we shall see a coal-burning gas turbine locomotive on the rails. This will have no water problems, will have an overall efficiency several times greater that that of the average reciprocating steam locomotive. Other objectives of the design are extremely high reliability and the saving of the coal market of the railroad locomotive into which serious inroads are being made at present by the Diesel locomotive.

The Complete Gas Turbine Power Plant

The foregoing are highlights of the present status of the gas turbine power plant in this country. They are discussed in more detail elsewhere in this issue in the first of a series on The Gas Turbine Power Plant.

In foreign countries, where the fuel situation differs from ours, much study has been given to the gas turbine. It was developed as a component of the Velox boiler. Today European manufacturers are actually building oil and gas-burning gas turbine plants for locomotives, portable railway type substations, power generation, blast furnace blowing, ship propulsion. The famous 4000-kw standby stationary power plant at Neuchatel, Switzerland built during the war, is the first one for strictly power generating purposes. But others are now under construction for installation in Europe and South America. Foreign builders are also pushing research to make the gas turbine burn coal.

Closed and Open Cycles

There is considerable interest abroad in the closed cycle gas turbine. Such plants have been designed for capacities of 50,000 to 100,000 kw, putting them into the range of capacity and efficiency useful to utilities, whereas the ordinary open cycle unit with regeneration has best efficiency in the capacity range from 1000 to 10,000 kw. It is of most interest to industrial and municipal plants but also of some interest to utilities for "spotting" and reinforcing capacity on large systems.

The closed cycle unit, however, requires an air or gas "heater" of nearly the same size as the boilers in a comparable steam plant. Furthermore, to attain high efficiency, the closed cycle plant requires water for intercooling, this bringing back the water problem.

Wet compression—water vapor sprayed into the air from the compressor for cooling, instead of in an intercooler—offers possibilities. Since the water must be pure, compression distillation might be used to produce it.

However, for conditions requiring power only up to 10,000 kw and perhaps small amounts of heating steam from a compact heat exchanger, as in industrial, small utility "re-enforcement" plants, municipal power plants and the like, the open-cycle gas-turbine plant should have many applications. For such services, it will supplement our present steam, Diesel and hydro plants. Nearly three dozen gas turbines can actually be seen now in operation. They will appear in the industrial power plant for power generation in a relatively short time.

The Mercury Vapor Plant

DURING THE WAR, developments in the mercury-vapor power plant moved very slowly. It may be expected, however, that they will come more rapidly in the future.

Before the war, the large mercury vapor plants at South Meadow, Schenectady and Kearny had been successfully operated. The important problem of the wetting of steel surfaces by mercury had been successfully solved by the simple method of using a mercury-sodium-titanium amalgam (magnesium later replaced the sodium in the amalgam). Present metallurgical developments may lead to solution of problems in building these plants for very high temperatures.

The latest of the units, the one at Kearny, operated for long periods at heat rates of approximately 9200 Btu per kwhr.

Smaller mercury units were tested at Lynn, Schenectady and Pittsfield, for capacities from 1000 to 2000 kw.

The large units were all installed as topping units and it has been considered that this is the widest application of the process, since any steam plant, according to Smith, no matter what its operating pressure and temperature, "can be given a new lease on economic life if mercury equipment is added." If and when topping is ever considered for the large number of 600 and 1250-psi plants built in recent years, here is an economical way to do it.

Further development work is under way at present, particularly in adapting the mercury plant to industrial purposes. A plant is now being built, for installation at Pittsfield, containing a 7500-kw mercury turbine and capable of supplying 120,000 lb per hr of process steam. A utility might use such a plant to furnish steam for industrial purposes, at the same time adding electric power to its system. All equipment, accessories and structures would be included and shipped in large factory-assembled units for ease of installation.

The mercury cycle lends itself well to standardization because steam pressures from 100 to 625 psig can be produced from the condenser boiler with only 10 per cent change in the mercury turbine generator output. A plant of standardized design, produced by repetitive manufacture, can be used to produce electric power output ranging from about 5000 or 7500 kw to 18,000 with by-product steam flow ranging from about 120,000 lb per hr to zero at pressures from 625 psi to zero.

Fuels and Combustion

THE PRESENT situation in the field of fuels and fuel burning is that:

1. Coal is still our basic fuel, burned by the majority of our power plants and it will be some time before other developments will change that fact.
2. Even though coal is our basic fuel, its cost is going up and its quality during the war has gone down. There are more problems nowadays in burning lower grade coals. Coal burning equipment must be able to burn economically a wide range of coals.
3. As a result, fuel oil and natural gas competition with coal is increasing.
4. The growth of smoke abatement campaigns makes it necessary for coal producers to give much attention to "smokeless" fuels and the manufacturers and users of coal-burning equipment to give much attention to elimination of smoke, fly-ash and contaminating gases from stack discharges.

During the war, it was necessary for industry generally to burn whatever coal it could get.

Coal-Burning Equipment

This has led to extensive use of the spreader stoker which has proved itself effective in burning a wide range of fuels. These have been built in capacities from the very smallest boilers up to units of approximately 250,000 lb per hr. One of the most recent installations of these is by a public utility company in a central station—Rockford—where spreader stokers will fire two 190,000 lb per hr boilers. Another large installation, using two spreader stokers back to back in one furnace is being planned for a 1250-psi industrial installation.

Pulverized coal is the fuel for a majority of central stations and there have been many developments in details of burning it in such plants. The slag-tap furnace is used in many cases. Improvements in details of pulverizers, feeders and burners have been made. External corrosion of furnace water wall tubes, occurring in a few plants, has been overcome by correcting furnace air distribution and other details. Design of heating surfaces, both radiant, convection and superheat, has been modified as much as possible to prevent slag accumulations.

Horizontal Cyclone Burner a New Development

However, for burning low-grade, high volatile and high ash coals without pulverizing, a notable development has recently been announced.

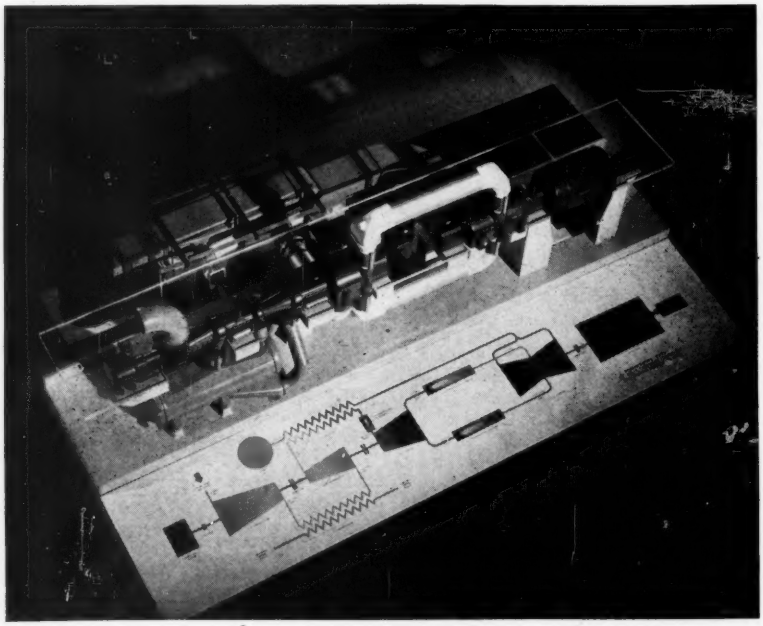


Fig. 9. View of model of Allis-Chalmers 10,000-kw gas turbine plant as designed for stationary applications, showing cycle diagram of plant at bottom

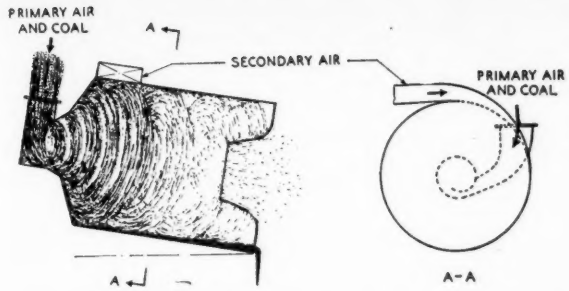


Fig. 10. Diagram showing operating principle of horizontal cyclone burner

For some time, engineers have been hearing about a "cyclone" burner for burning crushed coal in suspension. Details of this burner have finally been announced following tests of the burner for two years. A cyclone burner was installed on a 180,000-lb-per-hr 600-psi steam generating unit at Calumet Station of Commonwealth Edison Co. in September 1944. The principle of its operation is shown in Fig. 10. The burner, 8 ft in diameter and 11 ft long, is constructed as shown in Fig. 11 and is installed at the front and bottom of the furnace with the burner axis sloped about 5 deg toward the discharge end.

The object of the design is to improve the burning of high volatile coals having high ash of low fusing temperature, and the removal of slag from the furnace, preventing it from depositing on heat-absorption surfaces. Reports of the tests indicate that the burner has been successful in doing this, with a large reduction in volume and weight of steam generating unit as compared with a comparable pulzerized-coal burner design.

Operation of Cyclone Burner

In the cyclone burner, crushed coal and carrying or primary air are fed tangentially at high velocity through the coal inlet. Particles of coal are thrown to the surface of the cylinder and carried along in an increasing helical pitch path. In addition, sufficient secondary air for combustion is admitted at high velocity parallel to the coal stream, also a small amount of tertiary air. The volatile matter and carbon in the coal are burned, the molten ash and slag drain to the low point and are continuously tapped off.

Good combustion, with minimum excess air—as low as 8 per cent but generally about 13 per cent—is reported in the test unit; precise control of fuel-air ratio is beneficial but not vital. Great reduction in fly-ash emission is a feature; unburned carbon loss is about 0.1 per cent. The tests, it is claimed, have proved the principles involved to be sound, providing a simple reliable and efficient means of burning coals of lower grades with high percentage of ash with low fusing temperature. Ash-handling is much simplified, fly-ash reduced, first cost and maintenance are lower than pulverized coal, the boiler is kept cleaner.

Vertical cyclone burners will be tried, also combustion under pressure. The burner can be installed on new or existing installations, with much simplification of stack-gas-cleaning equipment. The cyclone burner is not necessarily a universal burner. There are limitations due to volatile content and ash-fusing temperature. Nevertheless, the burner holds forth many promises of simpler and cleaner methods of burning large quantities of low-grade coal.

Smoke Elimination

Because of the demand for smoke elimination in railroad, domestic heating and industrial coal burning, many refinements have been made. With the spreader stoker, considerable thought must be given to fly-ash collection following the boiler, recirculation of combustible matter for further burning, use of over-fire air. When these details are taken care of properly, the spreader stoker has given excellent results.

Use of over-fire air has long been more or less standard practice with chain grate stokers. But the use has now been widely extended to all types of furnaces through the intensive work of Engdahl and others. Over-fire air jets have been very helpful in reducing locomotive smoke emission. During the war, as a quick means of improving combustion where proper firing equipment or furnace could not be obtained, they have served so well that now they are being widely used as standard equipment. Engdahl has shown how over-fire air jets can be very simply constructed from common piping materials, how placed in the furnace, how supplied with air by steam jets or separate over-fire air fans and this information has been widely disseminated.

Dust Collection

Many types of mechanical collectors, electrostatic precipitators and gas washing devices are available for use in reducing stack emissions. And until every installation is so designed that there cannot be any such materials produced in the furnace, the subject will be of vital interest.

Problems of corrosion caused by boiler gases in economizers, ducts, stacks and other parts are being attacked by use of suitable metals and protective coatings. The influence of dew point of flue gases in these corrosion phenomena is now well known and in several installations it has been shown that the problems can be successfully overcome by proper design and operation.

Oil and Gas Fuels

Burning of oil and gas in stationary plants has many advantages in cleanliness and ease of control and in many cases it is used for these reasons even where the fuel economics is unfavorable. Spectacular changes in the art of refining crude oil were brought about by the war demands for new petroleum products, particularly aviation fuels. Nevertheless a considerable proportion of residual fuel oil continues to be produced from every barrel of crude. The proportion may vary from 15 to 30 per cent, according to the demand for other products. Therefore, an average yearly quantity of 335,000,000 bbl of residual fuel is available in the United States alone for consumption as industrial fuel.

Industrial oil burners installed in this country, says Bender, exclusive of those operated on board ships of the U. S. Navy, number about 350,000; their yearly production has increased from 18,433 in 1936 to 33,077 in 1945.

Fuel Competition

The recent strikes in the coal industry, threatening to tie up our entire transport and power system have aroused considerable discussion of the advisability of wider use of oil and gas for power generation. Many power plants, especially small ones, that burned oil before the war and were forced to convert to coal, now want to reconvert

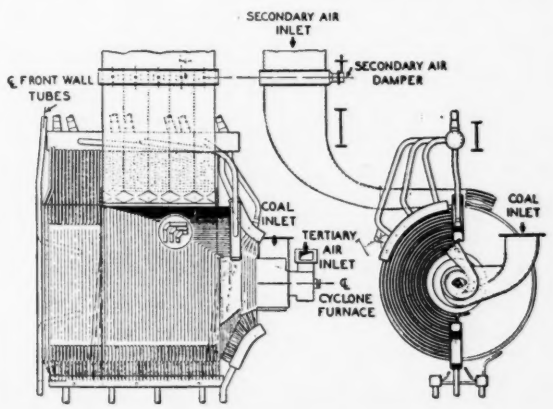


Fig. 11. Horizontal cyclone burner for burning low-grade crushed coal in suspension

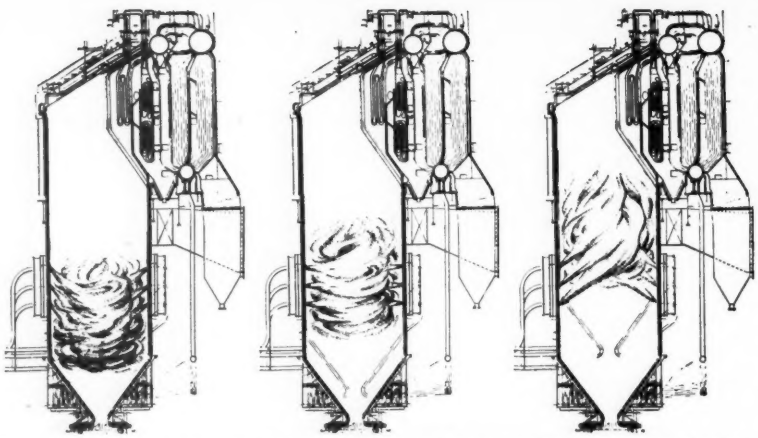


Fig. 12. Three views of typical Combustion Engineering Co. tangentially fired furnace showing use of tilting burners for acheiving superheat and slag control. Such burners are used in the 475,000 lb per hr, 1375-psi, 925-F units installed this year at Tidd plant

to oil and are doing so as rapidly as possible.

One of the most spectacular illustrations of the use of oil in an emergency was the installation of temporary oil burning equipment at Fisk and Northwest Stations to maintain them in full operation during the coal shortage last spring.

The oil and natural gas pipeline network covering parts of the country is solidly established and there are many reports of attempts being made by industries in those localities to convert to oil and gas firing wherever possible. It is significant that orders for oil and gas burning equipment show an upward trend, not connected directly with needed increase in capacity.

The Coal Atomizer

Much work is being done by the gas industry to develop low-cost gas manufacturing methods to make cheaper gas available. Production of gas with superheated steam and fluidized pulverized coal is being studied and it was to prepare coal for this process that the coal atomizer was originally developed.

This coal atomizer also offers a method of pulverizing coal for the gas-turbine locomotive without use of mechanical pulverizers in a mobile power plant. If pressurized combustion of this pulverized coal works out—it will soon be under full-scale test—a coal-burning locomotive will be available that will save the coal market both in fuel for locomotives and in haulage of coal. (In the first 6 months of 1946, domestic orders were placed for 426 Diesel locomotives but for only 44 steam locomotives). The total of coal tonnage hauled by the railroads is a little more than one-third of their total freight tonnage. So both the railroads and coal producers are interested in the competition of coal, oil and gas.

Under the present competitive situation, plants should be designed on the basis of fuels available. Where coal and oil are economically available, many plants provide alternate fuels. Where coal alone is to be the fuel, careful study of the original design of firing equipment, along the lines indicated by Tobey, Payne and many others, is essential.

Synthetic Gasoline and Cheap Oxygen

One of the most interesting recent announcements concerns the new Hydrocol process for synthesizing gasoline and Diesel oils from natural gas. It is of interest in the power field primarily for the fact that in this process it is necessary to produce oxygen. This, it is claimed, can be done very cheaply—about 5 cents per thousand cubic feet at present. This leads to interesting speculations: first as to the possibilities of producing gasoline from coal,—6-cent gasoline from $2.00 coal is visualized; second, gasifying coal and piping gases instead of transporting coal; third, to speculations about the possibilities of using oxygen, if it is cheap enough, directly in various combustion processes, either as pure oxygen or for the enrichment of combustion air. With pressurized combustion, this might lead to very high energy release in a very small combustion chamber.

Such ideas are not fantastic when we observe some of the things now being done. A large plant for the synthesizing of gasoline from natural gas is being designed for installation in Texas. Another large company is developing a plant for using variants of the process in another location. Plants for producing pipe line gas from coal are also being designed.

It is reliably reported that in Russia coal is being gasefied right in the mines, although no details of the process are given. Since what we really burn in any case is gas, this idea is carrying the coal burning idea to a conclusion, logical or otherwise.

Practical Applications of Oxygen with Fuels

However, ideas about using oxygen in connection with fuels were actually carried into practice by the Germans during the war. They used hydrogen peroxide, H_2O_2, to launch V-1 bombs, to drive fuel pumps in V-2 bombs, to drive torpedoes, certain airplane engines and submarines. Of most interest here is the Walter hydrogen-peroxide engine designed for submarines as shown in Fig. 13.

The Germans developed H_2O_2 in a very high concentration of about 80 to 85 per cent for 26 war weapons and had it in an experimental stage for 40-odd others. Since then it has been produced for use, in some cases, as a primary fuel, employing the heat of dissociation (about 1000 Btu per lb) of H_2O_2 into H_2O plus O_2. It was also used as a secondary fuel to supply oxygen, which was further burned with a fuel such as decalene, similar to Diesel oil. The second use is less costly, also there is larger heat release per pound of mixture. The principal value of using H_2O_2, according to McKee, is therefore its ability to furnish free O_2 when and where needed.

As developed for use in submarines, the engine shown in Fig. 13 was designed and its parts built for a 900-ton submarine. Aerial bombardment prevented the Germans from assembling it. However, Captain McKee collected the parts in 1945 and shipped them to England.

The engine is shown schematically in Fig. 13. There is a triple feed pump which pumps H_2O_2, Diesel oil and water. The hydrogen peroxide is pumped into a catalyst, where it breaks up into 80 per cent steam by volume and the remainder O_2, at about 930 F. The steam and O_2 flow to the combustion chamber; soon after it reaches the chamber, cooling water sprays into the working fluid. Soon after this the fluel is sprayed into the chamber.

The fuel is ignited and burns, the flame temperature being about 4000 F. The water is sprayed to reduce the temperature of the working fluid to about 1000 F. The working fluid—a mixture of about 94 per cent of steam by volume with the gases—then flows through what amounts to a conventional steam turbine, which turns the propeller.

In the actual engine there were many more complications than shown on the diagram and it was subject to many breakdowns. The submarine to use it was under construction at the end of the war, was designed to run submerged at 24 knots. The hydrogen peroxide engine, if it could have been assembled and used, would have been a good way to obtain oxygen for combustion when operating submerged. The biggest disadvantage would have been its cost—a thousand times greater than fuel oil—but that would have been of no importance in wartime.

Many references have previously been made to the advisability of investigating uses of oxygen in connection with combustion of fuels. The fact that the Germans actually did these things in rockets and other devices, even at high cost, should indicate that the ideas should be studied further.

Other Mechanical Developments

NEW IDEAS are fermenting everywhere and many of them are getting put into practical use. But here we can touch only the high spots. For instance:

Silicone Insulation and Lubricants

Silicones are synthetic substances developed primarily from brine, sand, coal and oil and they have many properties. They are being used for insulation of electrical conductors and they can be made into lubricants. Since they are synthetized, they replace materials derived from crude petroleum and if the supply of the latter becomes too badly depleted, as some fear it may, we shall not need to worry so much about lubrication for our machinery. Silicone greases, for example, may be made for bearing lubrication at temperatures ranging from −85 to +300 F; others are designed for temperatures of −4 to +482 F. As motor insulation they can be made for temperatures as high as 347 F.

Submerged Hydroelectric Generator

There was a new type of submerged hydroelectric turbine brought to light in Germany after the war and recently reported on by the Office of Technical Services. In this turbine, the rotor is constructed so that the hydraulic turbine runner, mounted on a horizontal shaft, becomes the spider of the generator rotor. That is, around the turbine rotor rim are mounted the coils of a rotating field, the entire rotor being inside a casing containing the stationary armature coils. The low water heads, 4 to 9 meters—about 13 to 28 ft—made it possible to seal the rotor to keep water out of the generator.

These units were set inside dams, which formed the turbine generator room, so that at high water the plant was entirely submerged. Costs were 50 per cent less than for conventional plants. Some of the plants had capacities of 7500 kw, but one large project in Austria was under construction for a capacity of 150,000 kw.

High Efficiencies of Hydraulic Turbines

In this country, hydraulic turbines have been developed for very high efficiencies, the single 60,000-hp Nantahala Francis type turbine, 1000 ft head, having an efficiency of 93.7 per cent at full load. High performance of this type has largely been reached through research, especially with the use of models. Because future gains must be attained in small steps and hydroelectric units and developments are becoming larger, small increases in efficiency are becoming greater in monetary value.

Studies of condenser circulating water intakes, pump suction passages and other water passages by use of models, has also led to much improvement.

Models of piping and often of complete power plants are used nowadays for study of details as well as of general arrangement for efficient operation. Use of models in preliminary studies of furnace design, in piping layout and other details of design are features of one new plant.

1600-cfs Pumps

One interesting hydraulic installation now being proposed will be the four 1600-cfs (cubic feet per *second*) vertical pumps, each driven by one 65,000-hp motor, to be installed at Grand Coulee to pump water for irrigation. These units, for which initial appropriations have now been approved, will have to be built on the basis of model tests.

Most of the capacity increase in hydroelectric turbines in the U. S. since 1940, about 5,000,000 hp, was in large Federal developments. However, because of total capacity increases in power generation, the hydro power remained at about ⅓ of the total.

Water power has been very important in Canada, furnishing a very large part of the total, some sources giving the figure of 98 per cent of total kilowatt hours. The largest single hydro-electric plant in the world, 1,140,000 hp, was built in Canada in record time to supply power for war-time production of aluminum.

Hydro in a Steam Plant

In this country an interesting application of a hydraulic turbine was made in a steam power station. Here the steam turbine and its condenser were set high above the level of the river that furnishes the condensing water. To reduce pumping costs, a hydraulic turbine was installed in the discharge line leading the circulating water back to the river. This turbine drives a circulating pump, supplementing the regular motor-driven pump.

Another development of recent years is the heat pump, advocated by Sporn and others as a means of air conditioning by electrical energy.

Heat pump installations have been in successful operation for several years, air conditioning commercial buildings for several electric utility companies. Testing has been done in dwelling houses. As a result of some recent developments by Webber, two commercial firms are designing for the market a small heat pump outfit for domestic use.

Radiant Heating

The whole subject of radiant heating is receiving much attention. The advantages of radiation from coils or heating elements housed in floors, walls, ceilings, have been demonstrated for many years and it is being installed in many commercial and domestic buildings.

An unusual development of the past year, reported by Oaks, is a high temperature liquid as a heat or energy transfer medium for domestic and industrial use. The substance called tetracresylsilicate is a liquid at all temperatures from −65 F to +817-825 F, boiling at the latter point.

The Diesel Plant

Practically the entire output of the Diesel engine industry was utilized for military purposes during the past 5 years. Consequently the pent-up demand for stationery, locomotive and truck Diesels is considerable, also for modernization, and new capacity to meet increased demands and reserve capacity.

During the war, improvements in Diesel and gas engines were largely in details of fuel injection equipment, design for higher rotative speeds, dual-fuel designs and the like.

A great many small capacity engines of around 15-hp capacity have been built. Opposed piston engines have been shown to have many advantages. Supercharging of Diesels, based on war-time experience, will doubtless be carried out on stationery engines to a greater extent.

Development of dual-fuel engines

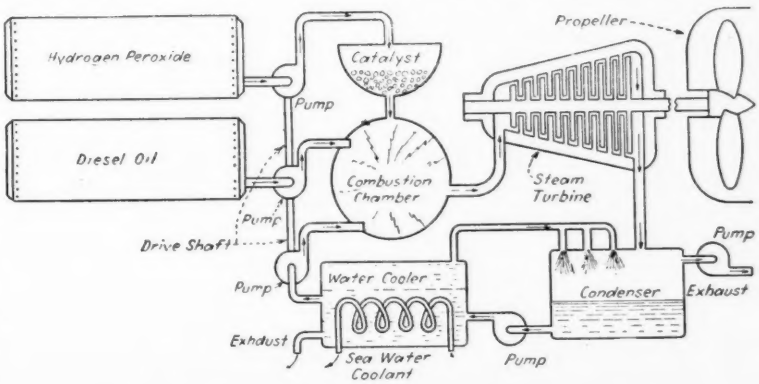


Fig. 13. Diagram of cycle for engine using hydrogen peroxide

burning gas or oil or a mixture of them has been rapid in recent years. Controls for these engines have been greatly simplified. Many of them are now equipped for supercharging.

Fabrication of engine parts by welding and use of cast crankshafts, new metals for bearings and cylinders, will aid in future design and operation.

Production lines for small Diesel engines, set up during the war, are now capable of turning them out in large quantities for peace-time uses. Engineers have suggested using these small engines in multiple-unit plants and automatic plants but the economic conditions for these would require careful analysis.

Atomic Energy

AS ALREADY mentioned earlier in this article, no consideration of future power developments can ignore the possibilities of using atomic energy for the generation of electrical power. As fuel costs go up the possibility of using atomic energy becomes more attractive. At the present time Eastern power plants pay around $7.00 a ton for coal. On the basis of theoretical calculations made by atomic scientists under the direction of Dr. Charles Thomas, vice president of Monsanto Chemical Co., the operating cost of an atomic power plant would equal that of a coal plant when coal costs were $10.00 a ton. An atomic power plant capable of producing 75,000 kilowatts of electrical power could be built at a cost of around 25 million dollars. Assuming that the plant would operate at 100 per cent capacity and with interest charges on the investment at 3 per cent, the operating cost of such a plant would run 0.8 cents per kilowatt-hour.

This is to be compared with a coal power plant which would cost $10,000,000 under the same conditions. The operating cost depends upon the price of coal. With coal at around $7.00 per ton delivered to the furnace of the power plant, the operating cost of the coal plant would be approximately 0.65 cents per kilowatt-hour. Here, also, as in the case of the nuclear power plant, it is assumed that the plant would operate at 100 per cent capacity, and with interest charges at 3 per cent.

Of course, these costs imply the successful solution of a number of difficult technological problems. In the case of the nuclear plant, the operating cost is greatly affected by the large investment which is reflected in the interest, depreciation and maintenance charges. The labor and supervision charges for the nuclear plant are expected to be greater than for the coal plant, until such time as the production of electrical power from nuclear energy has been further developed. It seems reasonable to expect that the future development of nuclear power will result in the standardization of design and construction, and a material reduction in the investment and operating cost.

The cost of power from coal is primarily determined by the price of coal, which constitutes about 55 per cent of the total operating cost. The prices of coal and fuel oil have increased considerably since before the war, and show signs of increasing still further in the future. It would appear that the cost of nuclear power may decrease and the cost of coal power may increase as time goes by, and that the development of nuclear power may prove to be attractive to those industries which are capable of undertaking the development.

Nuclear power plants would make feasible a greater decentralization of industry, a desirable factor in world economy. Only a trivial amount of fuel need be brought in, and the need for large cooling water supply might be obviated by the further development of the gas turbine.

Radioactive Isotopes

So much for nuclear power. The development of nuclear power will make available large quantities of radioactive isotopes which will have valuable uses in industry and medicine.

The Monsanto Chemical Co., which operates the Clinton Laboratories at Oak Ridge, Tenn. for the Manhattan District, reported recently that 160 orders had been filled by November 29, since sales were begun four months ago. It was further stated that the demand for the isotopes was steadily rising. While all the isotopes sold thus far weigh only a small fraction of a pound, they represent very great amounts in comparison with the meager quantities previously available through cyclotron production. The sales to date (November 29) have amounted to $21,600, or roughly their cost of production. In theory the same isotopes would have cost several millions of dollars if produced in cyclotrons. In practice, they simply would not have been available.

So far, the greatest demand has been for Carbon 14, produced in the pile for $367 per millicurie as against an estimated theoretical cost of several hundred thousand dollars per millicurie in a cyclotron. So far 45 lots of Carbon 14, totaling 37 millicuries, have been sold.

Carbon 14 is essentially a research tool being used to tag molecules so that their course in chemical reactions may be charted. It is being employed in a wide range of scientific studies, among them photosynthesis, metabolism, rubber chemistry, cancer research and chemical reaction rates.

Second on the demand list is Iodine 131, of which approximately 1300 millicuries in 42 lots have been sold primarily for experimental purposes in medical treatment. While it is true that radioactive isotopes are being used in cancer research, scientists are constantly seeking to discourage the false impression that radioactive isotopes can cure cancer.

The use of radioactive tracer isotopes is not new. It was one of the most widespread applications of nuclear

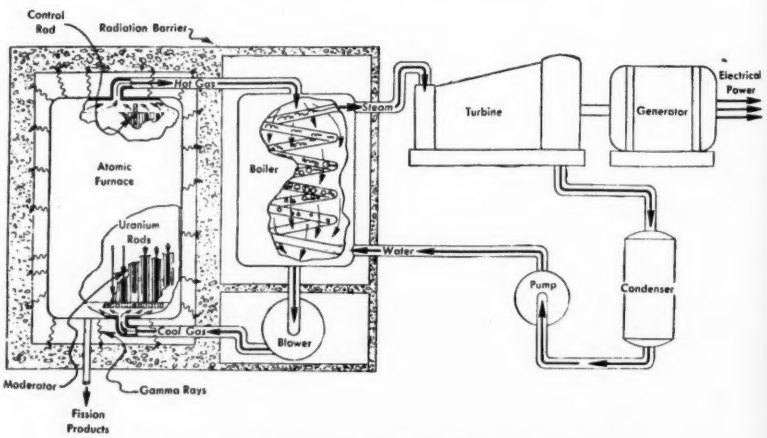


Fig. 14. Design for harnessing atomic energy to power plant

This schematic diagram pictures the projected power installation which the Monsanto Chemical Co. has contracted to build for the government at Oak Ridge, Tenn. It shows that the world's first atomic power plant will include all the elements of a conventional power station. The design and construction job is essentially one of finding ways to use a new and dangerous fuel. It is interesting to note that only the atomic pile-furnace and boiler will have to be shielded for the protection of personnel and against radioactivity. Apparently water heated to steam, by whatever heat transfer agent is used, will not carry radioactivity to the turbine

physics before the development of the atomic bomb. The method of radioactive indicators was a natural development from Madame Curie's initial work during experiments on the discovery and separation of polonium and radium. With the discovery of artificial radioactivity in 1934 by the Curie-Joliots and the perfection by Lawrence of the Cyclotron the whole art gained new impetus, and the use of isotopes as tracers became a major field of applied nuclear physics during the middle and late 1930's. Only then were tracer isotopes of all the chemical elements discovered and made available in quantities, together with the means of detecting them.

Until recently these radioactive tracers have been used largely in the field of medical diagnosis. Now, however, they are being used in industry. As reported in the December issue, in an article by S. Karrer, D. B. Cowie and P. L. Betz, at the Westport station of the Consolidated Gas Electric Light and Power Co. of Baltimore, this tracer method was successfully used in measuring the flow of water through one of the condensers. In these measurements the accuracy attained was within one per cent.

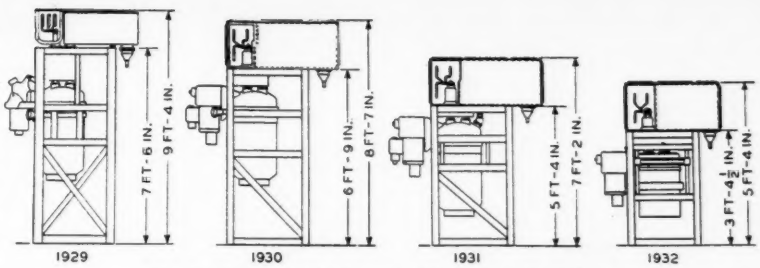


Fig. 15. Progressive development of indoor metal switchgear

Electrical Developments

THE MODERN ELECTRIC generator leaves little to be desired either in the way of efficiency or reliability. Recent developments in generator design have been in the perfection of certain refinements and in the improvement of the cooling systems. Nearly all large generators today are hydrogen cooled. The trend in future design will be along lines evolved in recent years. The average turbine generator of tomorrow will operate at high pressure and high temperature and will drive a 3600 rpm hydrogen-cooled generator.

The hydrogen pressures in turbine generators will be higher. This will result in the attainment of greater capacities. In the case of the new Springdale generating unit, for example, the generator is rated at 81,250 kva. This rating is with the hydrogen pressure at ½ psi. If, in this particular case, the hydrogen pressure is raised to 15 psi the generator capacity will be raised to 93,440 kva.

A significant trend in generator design is the attention being given to external appearance. Without prejudice to effective performance the external design of large units has been made more pleasing and streamlined. The most fundamental safety precautions require the shielding of many operating parts and special attention is being given to this factor so that a pleasing appearance consistent with the function of the machine results.

Transformers

Of particular interest in the field of transformer design is the construction of transformers for an operating voltage of 500,000, nearly 75 per cent greater voltage than that now carried by any transmission line. These transformers, made by Westinghouse are each 37 feet high were built for the American Gas & Electric Service Corporation's experimental line near Brilliant, Ohio. In this experimental work the A. G. & E. is seeking to determine the feasibility of transmitting electric power over longer distances and at greater voltages than ever attempted. As the present time the 287,000 volt line between Boulder Dam and Los Angeles, a distance of 250 miles, is the highest voltage line now in existence.

Switchgear

Development in switchgear has been following two lines, the continued improvement of oil and oil blast circuit breakers and the development of the air blast type of breaker. As already mentioned switchgear has been improved to the point where alternating current circuits of almost any capacity can be interrupted. In the case of the Grand Coulee tests, currents of 4,370,000 kva were successfully cleared with no apparent effort by the oil circuit breakers.

All A.C. circuit breakers depend for their operation upon the periodical occurrence of the "current zero" which represents a natural means of deionization. In direct current transmission no such current zeros occur and therefore the problem of current interruption by circuit breakers is much more difficult than in A.C. work. No really satisfactory D.C. breaker has yet been developed for the interruption of medium or heavy loads at high voltages. Considerable study, however, has been given the development of a vacuum type of switch which seems to offer possibilities for direct current work. As early as 1921 the first small vacuum switch was commercially built by the Swedish Birka Co. From 1923 to 1926 Sorensen and Mendenhall performed extensive tests with larger vacuum switches at the California Institute of Technology and in 1932 interesting investigations were carried out by Seitz and Jubitz in Germany. More recently further investigation of the vacuum switch was carried out by R. Koller of the University of California. Two types of vacuum switches used in Koller's investigation are shown in Fig. 17. One is a glass sealed switch, magnetically operated, the other an externally operated unit. While this work demonstrated that a very high vacuum is effective in aiding the interruption of direct currents, today, the vacuum switch is not yet able to compete in high power circuits.

Work on the development and improvement of current limiting power fuses has gone ahead steadily and such fuses are being used to an increasing extent on power circuits. The same is true of capacitors. Capacitor equipments complete with switches, control and protective devices have been designed and built into co-ordinated unit substation assemblies greatly simplifying installation and operation. Such units are used for both voltage regulation and kilovar control.

Capacitors are also being used to an increasing extent in electric welding practice, for energy storage and in specialized lighting service. High speed light flashers for professional and amateur photography and for signal equipment in lighthouses and airway beacon markers are made possible by energy storage capacitors. During the war, capacitors of new designs, with low inductance, very fast release, and reduced weight and volume, made such aerial flash photography feasible.

In a brief report such as this it is not possible to describe in detail all the various developments in such a vast branch of human endeavor as the electrical field. All we can do is point out some of the more significant developments and at the same time show the general trend of development in certain branches of the field. As David Prince of General Electric Co. pointed out in his Lamme Medal address recently, a new gain is often made possible by other previous gains. Thus as the snowball rolls, each time we discover something new and attain some new "unattainable" thing, each discovery gives us new vision. Fig. 15 for example shows how the size of

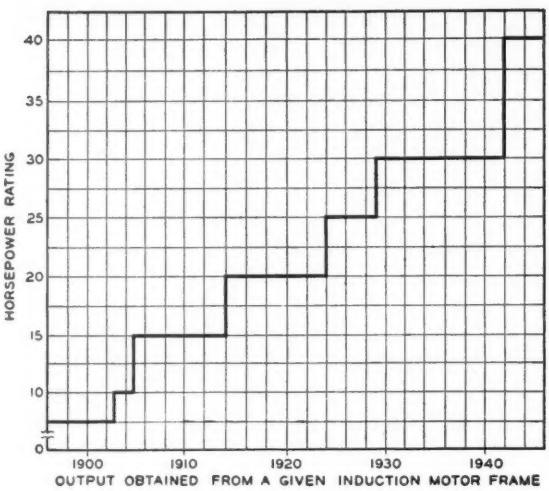


Fig. 16. Output obtained from a given induction motor frame

indoor metal-clad switchgear shrunk between 1929 and 1932 by the attainment of new knowledge. In the same way power transformers have shrunk nearly 50 per cent in size and weight.

Such advances are not limited to apparatus like transformers and capacitors which deal only with electricity. As David Prince indicated, the motor, standby for making the conversion from electricity to mechanical power, also shows a record of continuous advancement as shown by Fig. 16.

Thus far we have considered the advances in the more prosaic fields of heavy power apparatus—generators, motors, transformers, etc. When we examine some of the newer branches of the electrical art we find such amazing things as radar, the proximity fuse, microwave plumbing and thermisters. Amazing as these things are, the question is, what are they likely to lead to in the future. If by our knowledge of electricity we are able to solve such problems as that of the proximity fuse in a comparatively short time under the pressure of war, what are we likely to do with this knowledge over a period of years? In some ways, the development of the proximity fuse was one of the most difficult tasks ever undertaken by man, the atomic bomb not excepted. Open your table model radio and try to imagine how you would fit it, equipped with a power plant and a transmitter as well as a receiver and in addition a number of special precision controls, into the nose of a 5-in. shell in a space about the size of an ice cream cone. In the absence of any other requirements it would be a tight squeeze but now take into consideration the translational force applied in firing an anti-aircraft shell—approximately 20,000 times that of gravity. An electronic tube weighing less than an ounce under such conditions would be subjected to a force of over 1000 lb during the acceleration of the shell. In 1940, most conventional tubes gave a high percentage of failures when accelerated to merely 50 times gravity. Finally, to give the complete picture, imagine the immense centrifugal force applied to the radio set when the shell spins at speeds as high as 475 rotations per *second*.

That this problem was successfully solved is eloquent testimony to our knowledge and skill in the field of science and engineering. While the design of the fuse was essentially an electrical problem it also involved tremendous mechanical obstacles.

The perfection of radar technique during the war not only gave us new insight into the workings of very short waves but also brought forth such amazing devices as the cavity magnetron. Without the cavity magnetron it would have been impossible to generate the very high power ultra-high frequency radio waves needed in radar work. This tube is able to generate pulse power outputs of as high as 1000 kw at frequencies of the order of 15,000 to 20,000 megacycles.

In the handling of such high frequencies new methods for directing and reflecting the waves were developed. Long before the war effective use had been made of concave parabolic mirrors as radio antennas. More recently another optical type device has been successfully employed in directing very short waves, i.e., the lens. Such radio lenses are made of metal, in the form of metal strips, shaped almost exactly like a glass lens. By means of such metal lenses, short radio waves can be focused and directed exactly as light waves are focused and directed by glass lenses.

These lenses have been developed purely for communication work but as already pointed out, their "gain" is so high that a very large proportion of the total radiation is concentrated in such a small beam that it may prove that such beams could actually transmit appreciable amounts of electrical energy through space.

The Betatron

One very interesting development during the year just past was raising the voltage of the General Electric Co. Betatron at Schenectady, from 100,000,000 to 160,000,000 v. As described in the November, 1946 issue of POWER PLANT ENGINEERING, this was accomplished by the simple expedient of applying a d.c bias voltage to the a.c. voltage normally applied to the electromagnet of the unit. This new high voltage will greatly extend the usefulness of this new research tool. As pointed out several months ago by Dr. C. G. Suits, G.E. vice-president, we have now arrived at a stage where we can generate in the laboratory radiations which formerly were available only in the cosmic rays, and we are just passing the borders of an entirely new field of atomic research.

Aside from its usefulness as a research tool, the Betatron has already had practical application in industry. At the plant of the Allis-Chalmers Mfg. Co. a 20,000,000 v Betatron has been in operation for some time in the production of X-rays in industrial radiography. Still more recently, such a 20,000,000 v unit was installed at the Picatinny Arsenal at Dover, N.J. for use in x-raying castings and other metal parts. This unit can penetrate 20 in. of steel in 20 minutes and detect flaws of almost microscopic dimensions.

Miscellaneous Electrical Developments

Among the unusual electrical developments is a transparent electrically conductive coating on glass. This development, made by the Pittsburgh Plate Glass Co. is important in windshield de-icing. A coating of this general description is not new; a film of high electrical resistance has been used in the past on glass surfaces for prevention of electric charge collection, or electrostatic shielding. The new coating, however, exhibits the very important advantages of relatively low resistance and indestructibility. Instead of resistivities of the order of megohms, the new so-called NESA coating can be produced with a resistivity as low as 100 to 200 ohms per square, this being the resistance measured between opposite sides of a square sheet of any linear dimensions. Some idea of the thinness of the NESA coating is gained by considering that a film of copper having a resistivity of 100 ohms per square would be only seven billionths of an inch thick (assuming that the dimensional resistance properties are maintained for very thin sections, which may not be the case). This about 0.03 of one per cent of the wave length of light.

A windshield using the NESA film has been designed for a pressurized Douglas airplane which is expected to provide freedom from icing under the most severe anticipated conditions at any operating speed or altitude of the plane. This panel is approximately 13 in. wide, 28 in. long at the top and 31 in. at the bottom. A maximum power of 3100 Btu per hr per sq ft is to be dissipated by the NESA film which has a resistivity of 120 ohms per square. The heat requirements are such as to take care of de-icing under the severest atmospheric condi-

tions at ten degrees minus Fahrenheit, sea level, and 270 miles per hour, and assuming that the outer surface of the windshield is maintained at 35 F.

Electronic Frequency Meter and Speed Regulator

An electronic frequency meter and speed regulator has been developed to measure and hold the speed of a small steam turbine within plus or minus one-half of one per cent of any speed between 10,000 and 100,000 rpm.

This equipment fills the need for precise measuring and speed control apparatus required in the development and testing of very high speed machinery. In addition, the new circuits are of such basic nature that they readily can serve other applications for which no suitable commercial equipment is available. For use on machinery operating at speeds up to 100,000 rpm, the measuring instrument must not unbalance (and in some cases must not load) the moving part; therefore a photoelectric speed pickup is employed which requires no mechanical connection to the turbine shaft. The speed pickup, which can be placed several inches away from the turbine, merely "looks at" alternate black and polished areas on the surface of the turbine shaft and produces an electric signal whose frequency is some known multiple of the rotational frequency of the shaft.

Group Opinion Meter

Of unusual interest in the field of measurement is a new instrument designed to measure and indicate the composite opinion of a group of as many as 120 individuals. This device was developed at the General Electric Co. Called an opinion meter, the instrument enables each person in a group to express automatically, his opinion on any subject. All the individual opinions are summated and registered on a large dial as a single figure in about ten seconds. The instrument has possible use in schools, conference rooms, lecture groups, adult educational organizations, radio stations and political groups. The opinion meter consists of a large indicating unit and up to 120 hand-held stations. On the individual station is a dial calibrated from 0 to 100, and an adjustable pointer.

To register his degree of opinion on a question under discussion, each member of a group turns the pointer on his individual unit to a number on the dial. If strongly in favor of a question, this would be close to 100; if indifferent, 50 and if disapproving, close to the 0. The percentage of those in a group who turn their stations to "off" not desiring to express an opinion can also be determined.

Cooking By Magnetron

There has been much discussion concerning the possibility of using radar techniques in industry. Thus far few radar principles have been found applicable to industrial processes but the use of the high frequency generators used in radar work shows considerable promise of being useful in certain heating applications. The cavity magnetron is very useful in such applications because of the high power output of such tubes. An interesting new equipment using the magnetron is the "Radarange" which uses ultra-high frequency electromagnetic power to defrost, heat, or cook a wide variety of foods in a matter of seconds. This equipment was developed by the Raytheon Manufacturing Co. A special model developed for use by the air lines weighs approximately 100 lb is designed to defrost and cook a complete meal (which has previously been partially cooked) in less than one minute. The unit operates on about 4½ kw from the standard 28-v d-c power system. The 400-cycle output of motor generator sets is amplified and rectified to produce direct current at 4000 v which is applied to the plate of a continuous-wave magnetron oscillator. The 3000 megacycle, 1000 watt output of the magnetron is fed to a 4 by 8-in. wave guide by a coaxial cable. The wave guide directs the power to the food which has been placed in a metal tray. The tray acts as a reflector, thereby forcing any stray energy back into the food. Another model for use in drug-stores and sandwich shops is ready for production, and a radarange for home use is being developed.

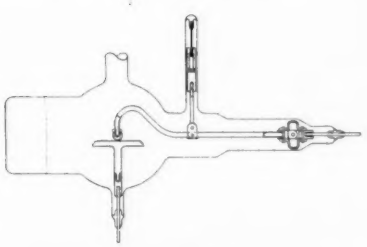
This unique cooking device produces hamburgers in 35 seconds. Gingerbread actually can be seen to rise from batter to fluffy muffins in 29 seconds. These muffins have no crusts because the heat is generated in each molecule of the dough and does not have to be conducted from the surface. Hot dogs can be cooked in paper wrappings without burning the paper.

Electric Power and Aeronautical Research

Behind the scenes of the rapid development of aeronautics in this country in recent years are the aeronautical research laboratories. These laboratories are of interest to the electrical engineer because of the surprising magnitude of their electric power loads. One of the largest aeronautical laboratories in terms of electric power is the Ames Aeronautical Laboratory of the National Advisory Committee for Aeronautics, located at Moffett Field, Cal. This laboratory, on which construction was started in 1939, has developed rapidly to the point where it is now the largest single connected load on the Pacific Gas and Electric Company's system. With the completion of wind tunnels now under construction this laboratory will have over 150,000 connected horsepower. Most of this power is used for the wind tunnel fan drives.

Special Motors

Some truly amazing things have been done in designing small, high power, high speed motors for aeronautical research. In scaling down the operation of propellers from full scale sizes to those used on models it is neecssary to observe the principle of similitude. Thus if a full scale propeller operates at 1500 rpm, the propeller on a 1/10 scale model would have to turn at 15,000 rpm. To get so much speed and power within the available space, all possible means must be taken to keep size to a minimum. Consequently the motors are water cooled and are operated at temperatures which would not be tolerated in ordinary motors. A few small motors have even used carbon dioxide from high pressure cylinders as a refrigerant for cooling. As examples of what can be obtained in motors of this type, motors rated at 22 hp at 12,000 rpm and measuring only 4½ in. in diameter by 12 in. long and motors rated at 100 hp at 10,000 rpm measuring 8 in. in diameter by 16⅜ in. in length are typical of water-cooled models. A motor 2 in. in diameter by 7⅝ in. long is available rated 4 hp at 18,000 rpm with combined water and carbon dioxide cooling. These motors for models are usually designed to carry their rated loads for approximately 20 minutes, which allows sufficient time for the average test.



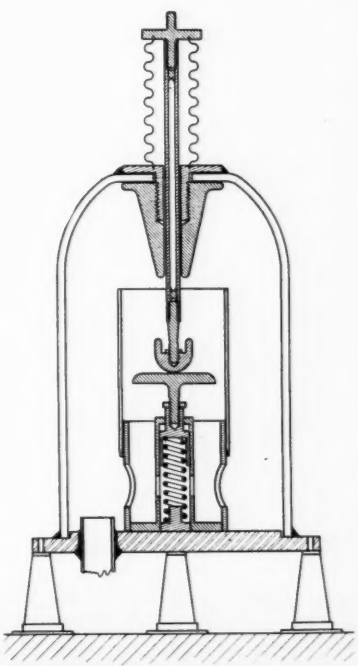


Fig. 17. Two types of vacuum switches. A. Glass sealed vacuum switch, magnetically operated. B. Demountable, externally operated vacuum switch

The Gas Turbine Power Plant-I

By JOHN I. YELLOTT

Director of Research, Locomotive Development Committee, Bituminous Coal Research, Inc.

Here is the first of a series of articles forming the first textbook to be written on the gas turbine power plant as a whole . . . It is written by a man who is actually designing and building such a plant . . . Furthermore, he expects to teach the gas turbine in this plant to burn coal . . . Still further, he gets right down to cases in this first article and puts numbers on the gas turbine power plant . . . Just what would a 5000-hp power plant be like? . . . What cycles can be used? . . . Open-cycle plant uses no water . . . What equipment would it require? . . . How much fuel and air? . . . How make preliminary calculations of performance? . . . How would it compare in equipment, space and performance with a steam power plant? . . . How do existing plants guide in future design? . . . Part II in a subsequent issue will go directly into detailed calculations of open-cycle plant and its performance, use of air charts and tables, etc. . . . Other articles will cover: calculations for turbine air rate, gland leakage, radiation; combustors; piping and duct sizes; accessories . . . Cycle computations, straight line relations, part-load performance, the Parsons line will be treated . . . Full details on coal, oil and gas burning problems . . . Operation and control of plant . . . Comparison of gas turbine and steam plants and economics of both will be included later

THE COMBUSTION GAS TURBINE has, during the past ten years, changed from a thermodynamic curiosity into an engineering reality. First applied to the task of supercharging aircraft engines, oil refining processes, and forced circulation steam generators, the gas turbine power plant is already dominating the field of high speed flight. In addition, its unique characteristics are winning for it a place in both marine and stationary applications. In its fundamental principles, the combustion gas turbine is almost as old as the steam plant, for John Barber was granted an English patent in 1791 on a combination which contained all of the elements of the open-cycle gas turbine power plant.

Although the gas turbine plant is the simplest of all practical power generating systems, it remained beyond the realm of effective application until a combination of developments occurred during the late 1930's. The perfection of the efficient axial-flow compressor and the evolution of metals with adequate strength at temperatures above 1000 F took place almost simultaneously. Given these two essential assets, engineers in many countries were able to build practical gas turbine plants.[1] (See references at end of article). The pioneering developments of the Brown-Boveri Co. in Switzerland[2] must be recognized in any comprehensive review of the gas turbine, for theirs were the first power-generating units. The work of Moss on the aircraft turbocharger, of Buchi on the Diesel supercharger, and of Whittle on jet propulsion, must also receive adequate recognition.

The grim necessity of war was responsible for the tremendously rapid development of the gas turbine as an aircraft power plant. The knowledge, as early as 1941, that the Germans were actually flying jet planes spurred Great Britain and the United States to the expenditure of the money and effort necessary to develop the high temperature alloys essential to the operation of jet propelled aircraft. The availability of these alloys, and of the highly efficient compressors which were concurrently developed, has made the gas turbine a formidable contender in the highly competitive field of power generation.[3]

Although its spectacular appearance in the high-speed airplane has received great publicity since the veil of secrecy was lifted in 1944, even more important applications are just ahead in marine and land transportation and in stationary plants. The purpose of the current series of articles is to analyze the gas turbine in the light of present knowledge, and to show how its performance can be calculated. Power engineers will be supplied with the information which they need to evaluate the possibilities of the gas turbine in their own plants and processes.

Gas Turbine Cycles and Definitions

Just as the steam cycle has given rise to a language all its own, so the gas turbine plant is beginning to be characterized by its peculiar terminology. The term "gas turbine" is itself often

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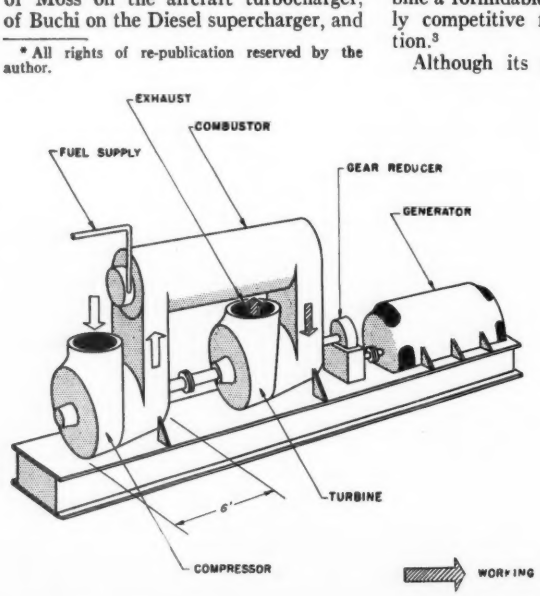


Fig. 1. The open-cycle gas turbine

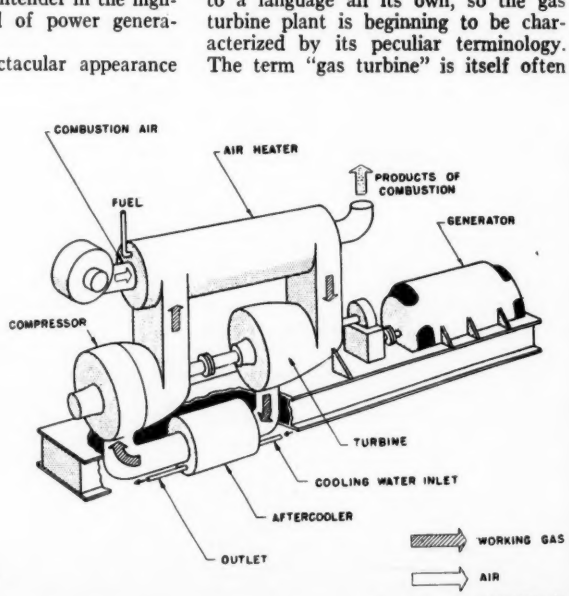
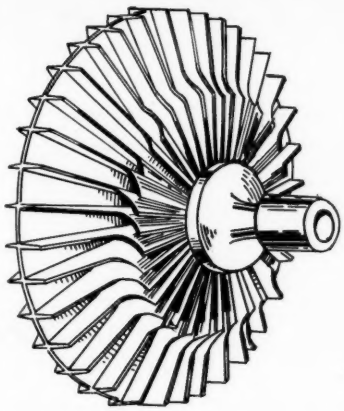


Fig. 2. The closed-cycle gas turbine



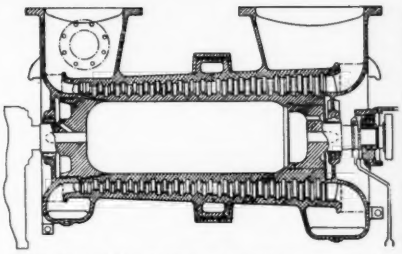


Fig. 3 (Left). Sketch of impeller of General Electric centrifugal compressor as used in aircraft

Fig. 4 (Above). Sketch of 20-stage Allis-Chalmers axial flow compressor as incorporated in 3500-hp gas turbine unit at Annapolis

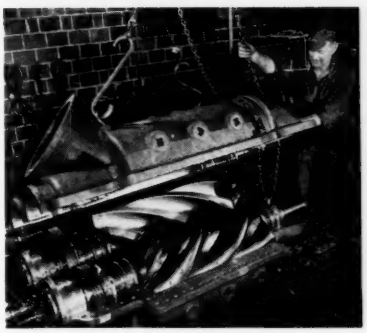


Fig. 5. View of Elliott-Lysholm positive displacement compressor. Lobes of rotors trap and compress the air

misinterpreted; the expression simply denotes the fact that the turbine is driven by a gaseous material—one which is neither condensed nor evaporated at any stage in the cycle. Even at the beginning, however, an exception must be made to admit the interesting possibility of improving performance by injecting a liquid into the compressed air at some strategic point in the cycle. A workable definition of a gas turbine plant would merely state that its principal working fluid is a permanent gas, and its prime mover is a turbine.

Two distinct types of gas turbine plants have already made their appearance. The simplest, and hence the most widely used, is the "open-cycle" plant, shown in Fig. 1. The compressor draws in atmospheric air and raises its pressure to a suitable value, ranging from 45 to 120 psia. The fuel is burned directly in the compressed air stream in the "combustor," thus heating the air to the highest temperature which can be withstood by the materials used in the high-pressure portion of the turbine. The air, continuously compressed and heated, then passes through the turbine, doing enough work on its rotating blades to drive the compressor and to leave, if all of the operating conditions are favorable, a respectable dividend of power in the form of useful shaft work. The turbine exhausts directly to the atmosphere. The exit velocity, in the case of jet-propelled aircraft, can be utilized to do the useful work.

Open-Cycle Simplicity

The open-cycle gas turbine possesses to a higher degree than any other prime mover the virtue of simplicity. Its two moving parts—the rotors of the turbine and compressor—necessarily spin at high speed and are therefore made both small and light. No water is needed in the cycle, since there is no necessity of cooling the exhaust. The type of fuel which can be employed is limited only by the possibility of damaging the turbine if the combustion products contain harmful solid particles or corrosive gases. Although the efficiency of the simple open cycle is relatively low, it is higher than that of a non-condensing steam plant. Also, it is open to very marked improvement without excessive complications. So attractive, in fact, is this cycle [3 and 4] that a detailed study will be made of it in a subsequent section of this article.

The Closed Cycle

The second major type of gas turbine plant operates on the "closed cycle," shown in Fig. 2. Here the prime mover is again a turbine, but the working gas is no longer restricted to air. Instead, any permanent gas can be used which is suitable for the purpose, for the heat is added by transfer in a heater, rather than by direct combustion. The working gas has its pressure increased in the compressor to an appropriate point, and its temperature is then raised as it passes through the tubes of the "gas heater." No mixing need take place between the combustion products and the working gas, hence solid fuels immediately become a possible source of heat for the

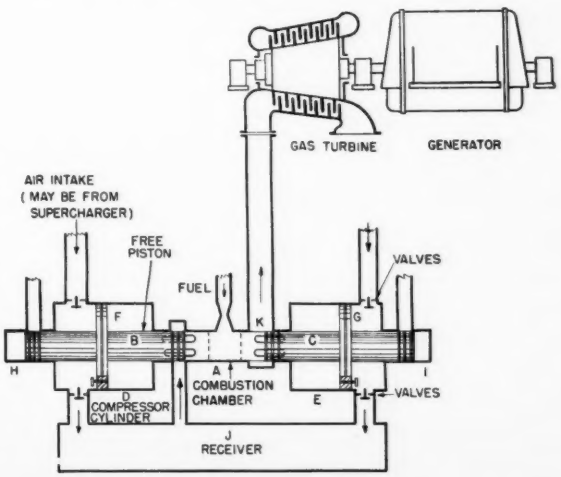


Fig. 6. Schematic diagram of free-piston compressor-gas turbine arrangement.

Fuel burned in A; Diesel explosion drives pistons B and C apart, compressing and heating air in cylinders F and G. As pistons uncover exhaust ports, air scavenges combustion chamber; hot gas flows to gas turbine. "Bouncing" of pistons in H and I forces them back for another firing stroke. Speeds may be several hundred cycles per minute

THE AUTHOR

JOHN I. YELLOTT has been director of research for the Locomotive Development Committee at Baltimore, Md., since May 1, 1945. This committee was formed by a group of the nation's leading railroads and coal producers, cooperating with Bituminous Coal Research, Inc., to develop new types of coal-burning locomotives.

Mr. Yellott has worked principally on the development of a coal-burning gas turbine locomotive and has pushed this program so vigorously that, at this writing, such a locomotive appears to be only about 18 months from reality.

Mr. Yellott's unusual and outstanding experience as mechanical engineer, research worker, teacher and administrator have all led up to his present work. From September 1943 to May 1945 he was director of the Institute of Gas Technology in Chicago, where he and his associate A. D. Singh developed the coal atomizer for pulverizing coal which will be used in the coal-burning gas turbine locomotive. Before that, Mr. Yellott had for three years been chairman of the department of mechanical engineering at Illinois Institute of Technology.

At that time he had already attained a national reputation in the power field for his studies of steam flow and nozzles and the practical applications of the studies in solving specific problems. In 1937 he was named the outstanding young mechanical engineer of the decade by Pi Tau Sigma; in 1942 he was cited as the outstanding young man of the year by the Chicago and Illinois Chambers of Commerce for his work as director of the war training program at IIT. He is an honor graduate in mechanical engineering from the Johns Hopkins University.

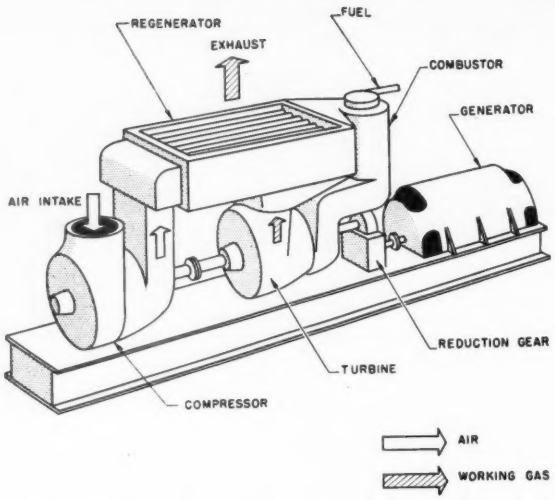


Fig. 7. Open-cycle gas turbine with regenerator

closed cycle. The turbine again extracts from the working gas enough energy to drive the compressor and to supply the shaft load, and the exhaust gas passes out at approximately the pressure prevailing at the compressor inlet. This exhaust gas is still very hot, however, and so it must have its temperature further reduced by passing through the after-cooler. Here the unusable heat is removed by transfer to the cooling water, so that the compressor work will not be excessive.

The closed cycle [4 and 7] can operate at any reasonable compressor inlet pressure, such as 150 psia, hence the density of the working fluid can be ten times as great as that of a comparable open cycle unit. Thus, for a given size of turbine and compressor, the capacity of the unit can be far greater than the open cycle can currently achieve. In addition, the efficiency of the closed cycle can without difficulty exceed that of the open cycle working at the same turbine inlet temperature. Efficiencies approaching the mark set by the Diesel have already been reached by an experimental plant built by Escher-Wyss in Switzerland.

The major drawback to the closed cycle is the necessity for more heat transfer than is required by the open cycle. It is to be expected that the closed cycle will be in direct competition with steam plants where high efficiency is needed in units of large capacity.

Other Parts of Gas Turbine Plant—Especially Compressors

Several additional terms should be mentioned before a more detailed study of gas turbine cycles is undertaken.[5] The compressor is the heart of the gas turbine plant, for without a highly efficient means of increasing the pressure of great volumes of air, no gas turbine cycle can become a reality. Three major types of compressors are in practical use today. The single-stage centrifugal type has long been used where a pressure ratio (discharge pressure divided by inlet pressure, in psi abs) of two to one was adequate. For higher ratios, several stages must be used in series, as in the familiar blast furnace blowers. Numerically, the centrifugal compressor on the aircraft turbo-supercharger far outnumbers all other types combined, for these were built during the war in astronomical quantities. Single-stage centrifugals are also used on many of the jet-propelled aircraft, for Whittle used this type in his pioneering work.

As Fig. 3 indicates, the centrifugal compressor is simple and light. Its efficiency is not as high as the axial's, and the maximum pressure ratio which it can attain is not much in excess of two.

The axial compressor in operation resembles a reaction turbine running backwards. It is composed of a relatively large number of rows of stationary and moving blades, with each row contributing to the pressure rise. The blades look more like miniature airplane propellers than turbine buckets, however, and the successful designs have been based on aerodynamic theory. High pressure ratios can be reached by using a large number of stages, and very high efficiencies can be attained. Most power gas turbine plants have used the axial compressor because of its suitable qualities of large capacity, excellent efficiency, and adequate pressure ratio. Fig. 4 shows the twenty-stage Allis-Chalmers compressor which forms a part of the Navy's test plant at Annapolis.[12]

The only positive displacement compressor currently used in a gas turbine plant is the Elliott-Lysholm, shown in Fig. 5. This is a two-rotor machine [9] in which the air is trapped in the space between the rotors and compressed as the lobes move towards each other. Its efficiency is midway between the values which can be reached by the axial and the centrifugal, but it cannot yet be built in the large sizes which can be attained by the axial.

Piston-type compressors [11] are ordi-

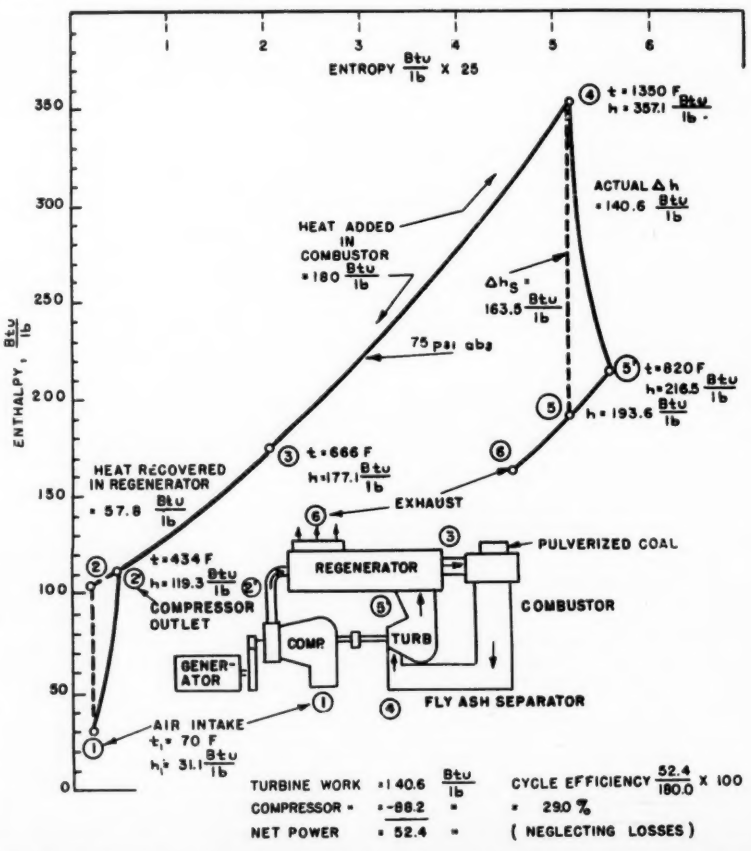
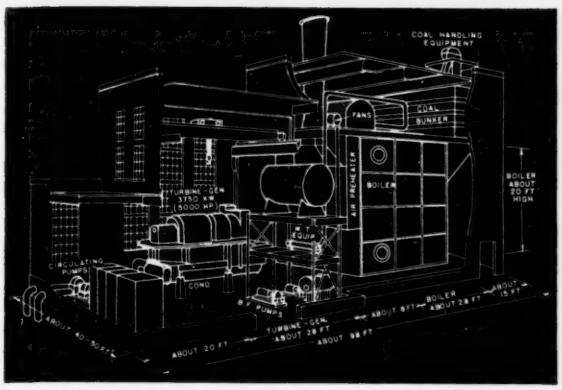
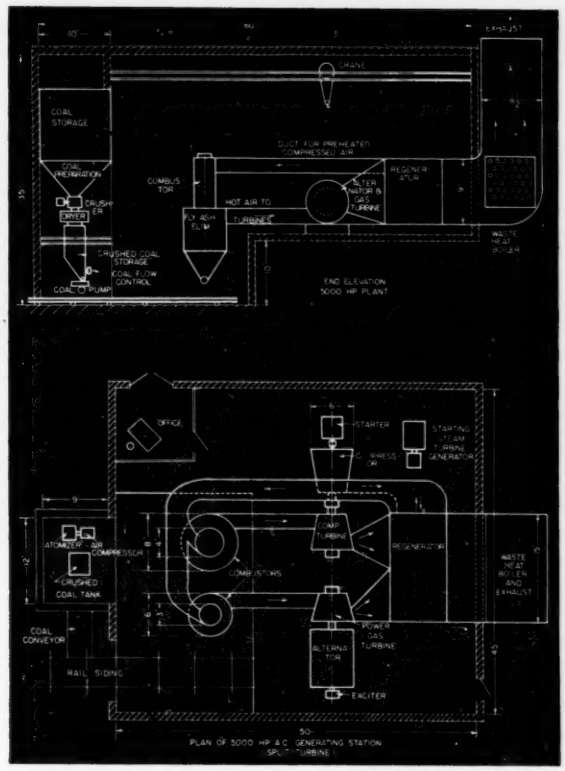


Fig. 8. Mollier diagram for the open-cycle gas turbine with regenerator, showing how heat is added and rejected





narily far too low in capacity for consideration in the gas turbine plant, but an exception to the general rule is the free-piston type, Fig. 6. Two opposed pistons are used to obtain a combination of Diesel action in the center of the unit and ordinary compression in the two outer cylinders. "Bouncing pistons" are used to return the mechanism to the firing position. By using three or more such units with a single gas turbine, a high efficiency can be obtained.

Fig. 9. Comparison of relative volumes of a steam power plant of 3750-kw capacity — approximately 5000 hp—with a 5000 hp gas turbine power plant

Intercoolers, Reheaters, Regenerators

Use of an "intercooler" to reduce the work of compression is a familiar matter to mechanical engineers, and the gas turbine plant is merely following conventional practice in trying to achieve isothermal compression. Water is almost universally employed as the cooling medium, for air-to-air heat exchangers would be exorbitantly large.

A "reheater" is sometimes used to heat the air or other working gas after it has expanded partially through the turbine. Here again the mechanical engineer is on familiar territory, for steam reheaters have been employed for many years as a method of reaching for the ultimate in station efficiency. The gas turbine's reheater is usually direct-fired, however, for the oxygen content of the high pressure turbine exhaust is still more than adequate to maintain combustion.

One more piece of apparatus should be mentioned before the usefulness of the gas turbine is discussed. The most effective means of increasing cycle efficiency is the "regenerator," Fig. 7, which transfers some of the otherwise wasted heat in the turbine exhaust to the high pressure air as it proceeds from the compressor to the combustor. An increase of about 25 per cent in cycle efficiency can be brought about by this simple process, which is usually enough to justify the addition of the regenerator to the cycle. The regenerator is rated in terms of its "effectiveness," which is the ratio of the heat gained by the compressed air to the amount of heat available for recovery. The compressor adds several hundred degrees to the air temperature, and even a perfect regenerator could only cool the exhaust down to the compressor outlet temperature.

Introduction to Cycle Performance

The rapidly expanding literature of the gas turbine relates that locomotives, ships, and aircraft are already being propelled by the new prime mover, while a number of plants are in use for land power generation. No further argument need be given to demonstrate that the gas turbine plant is a practical solution to a number of power problems. The economic justification is open to debate, however, until facts are at hand to support the optimistic predictions which are often made by gas turbine enthusiasts. Fortunately, the performance of a gas turbine is easy to estimate, and the thermodynamics need not go beyond that to which any junior engineering student is exposed in college.

Tables of the properties of air are not as well known yet as are the far more complicated steam tables. Since the air used in a gas turbine is always very highly superheated, the perfect gas laws hold with all the accuracy required by the usual calculation. The enthalpy of air thus depends only on its temperature, and this fact greatly simplifies the calculations. A very simple Mollier diagram for a typical open cycle is shown in Fig. 8, with the necessary apparatus superimposed. The Keenan and Kaye tables of the properties of air were used for this calculation. A later article in this series will comment in detail on the use of tables and charts in the calculation of gas turbine cycle performance. The selection of the cycle conditions used in Fig. 8 will also be justified subsequently.

The energy quantities involved in operating the cycle of Fig. 8 are all given in terms of a single pound of dry air. Actually, there will be some humidity in the air, and combustion products will be added when the fuel is burned. For purposes of comparison, however, these additions may be neglected without serious error. The efficiency of the cycle may be defined as:

$$E = \frac{\text{net work output of the turbine shaft}}{\text{heat input to the combustor}}$$

The compression ratio selected for Fig. 8 was 5.0, which, with an initial pressure of 14.7 psia, gives a compressor outlet pressure of 73.5 psia or 58.8 psig. An ideal compressor would re-

Table 1. Simple Cycle Computation

	Ideal	Assumed Efficiency	Actual
(1) Work done by air in the turbine	163.5	86%	140.6 Btu per lb
(2) Work done on air by the compressor	74.2	84%	88.2 Btu per lb
(3) Net shaft work available	89.3		52.4 Btu per lb
(4) Heat added in the combustor	251.8		237.8 Btu per lb
(5) Cycle efficiency (3) ÷ (4)	35.6%		22.1%
(6) Air Rate 2545 ÷ (3)	28.5		48.6 lb per hp. hr

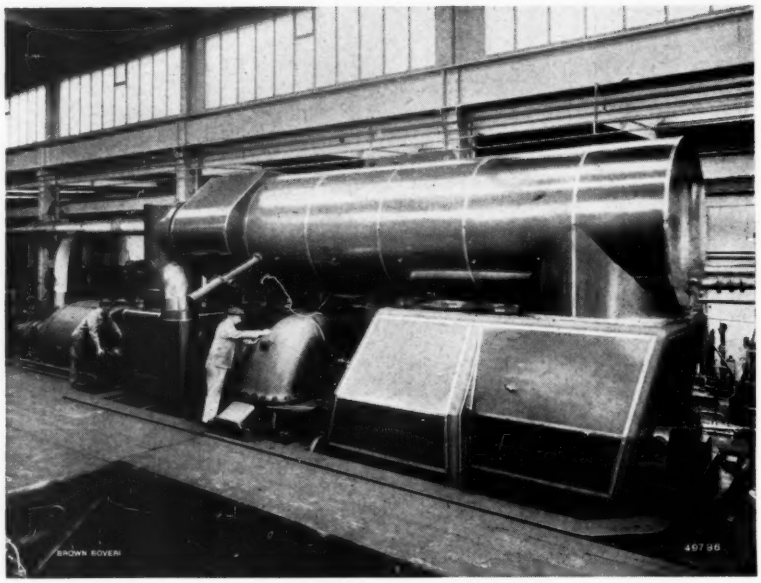


Fig. 10. Brown-Boveri peak load or stand-by plant for Neufchatel on test at factory before installation

quire a power input of 74.2 Btu to accomplish this rise in pressure for the pound of air, starting at 70 F. It will be of interest to tabulate the cycle quantities for the unattainable ideal as well as the attainable real conditions. Table I, which is arranged for convenience in calculation, lists the appropriate values, using efficiencies which will be justified in a later article.

Several important omissions in Table I should be acknowledged here. The combustion of the fuel will certainly not be perfect, and a combustor efficiency of 96 per cent would reduce cycle efficiency to $0.96 \times 22.1 = 21.2$ per cent. A pressure loss of some 4 psi between the compressor outlet and the turbine inlet would reduce the efficiency by an additional 5 per cent, to an even 20.0 per cent.

The air quantity needed for a shaft output of 5000 hp is:

$$\text{cu ft of free air per min} = (243{,}000 \div 60) \times 13.35 = 54{,}300$$

Using the estimated 20 per cent efficiency, the heat input per hour must be:

$$\text{Btu input per hour} = 5000 \times 2545 \div 0.20 = 64{,}000{,}000$$

It has been mentioned previously that the addition of a regenerator was usually desirable. Figure 8 shows at point 3 the condition of the compressed air leaving a regenerator of 60 per cent effectiveness. Heat in the amount of 57.8 Btu per lb has been recovered, and the combustor need now add only 180 Btu per lb of air. The turbine and compressor work remain unchanged, so the cycle efficiency is now raised to:

$$E = (52.4 \div 180) \times 100 = 29.1 \text{ per cent}$$

Reducing this value by the amount of the losses due to imperfect combustion and pressure loss, the cycle efficiency still remains at about 26.5 per cent. The necessary fuel input is approximately 48,500,000 Btu per hr.

It should be recalled at this point that the cycle in question employs no water, and that the necessary equipment will weigh only about 15 lb per hp, exclusive of the generator. The volume required will be about 0.5 cu ft per shaft hp. Comparison with a 5000-hp steam plant of modern design, complete with condenser, superheated steam generator, regenerative feed water heaters, and all of the other efficiency-minded accessories is very enlightening. Figure 9 gives an approximate idea of the relative sizes of the two plants. The full-load thermal efficiency of the steam plant can reach about 23 per cent, thus requiring a fuel input of some 53,000,000 Btu per hr.

The advantages in compactness, lightness, and simplicity are all on the side of the gas turbine plant. Only where large quantities of process heat are required does the steam plant show superiority. The steam plant will probably burn coal, either on a stoker or in pulverized form. At the present time, liquid fuels or by-product heat run all of the gas turbines currently in operation. However, it is expected that bituminous coal-fired gas turbines will be in use within eighteen months. When this long-awaited development comes to reality, a new appraisal of power economics will be in order.

To summarize the gas turbine power plant's present position, it can be said that this new prime mover is ready to step into its place in the power field. Where good efficiency is needed in units of moderate size, where water is scarce or entirely absent, where simplicity, small size, and lightness are at a premium, the gas turbine will supply an economical answer.

Present Fields of Use

Prior to Warld War II, the gas turbine had achieved commercial status in three fields. In each field, efficiency was secondary to some other characteristic, and turbine inlet temperature was restricted to the vicinity of 1000 F. The largest user, numerically speaking, was the Houdry oil refining process,[10] for which many successful units have been built by Allis-Chalmers and Brown-Boveri.

In this process, large quantities of compressed fresh air are needed to burn carbonaceous deposits from the granular catalyst after a brief period of contact with petroleum vapor. Compressed air at about 40 psia is needed, in order to keep the size of the catalyst cases down. By using large axial compressors, the necessary air quantity and pressure can be obtained. The energy for driving the compressor is supplied by the air,

(Continued on page 132)

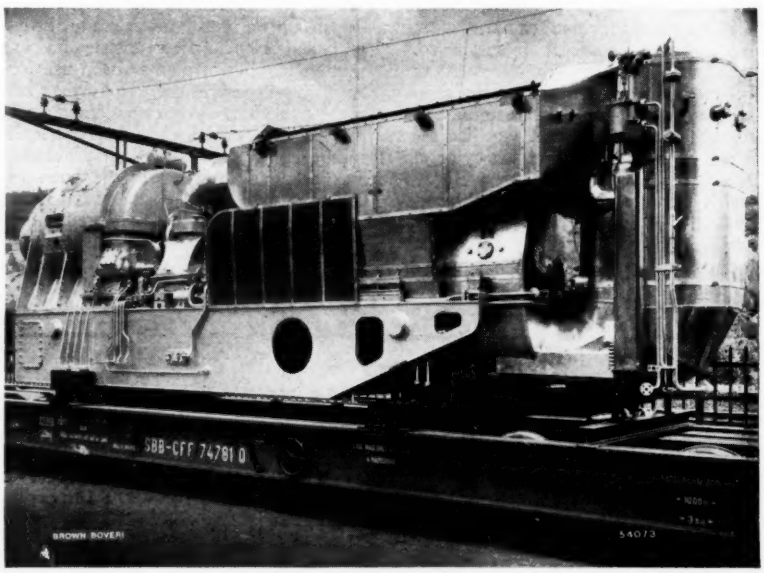


Fig. 11. The complete gas turbine power plant as installed in a locomotive by Brown-Boveri

The PRACTICAL ENGINEER *and* ELECTRICIAN

ANDREW W. KRAMER, EDITOR

Oil on "Troubled Waters" *

Coal! The name has a significant sound to the engineer just now in view of the scarcity of the article. The great coal strike has had an effect upon the manufacturers which will be felt for some time, and there is, no doubt, that ere such a thing occurs again we shall see a great many of the present coal users prepared for the struggle, and that in a manner which bodes ill both for the miner and the operator.

With the unlimited supply of fuel oil, from Texas and other places, has come the application of the oil burner to the steam-boiler. The results attained daily are indeed flattering to the oil people. A number of the Southern railroads have applied the burners to their engines recently because of their inability to obtain the proper quantities of coal to operate with. In every case where this has occurred there has been an economy in the use of the oil; of course this is partly due to the fact that it has only been adopted in those portions of the country directly adjoining the oil fields. But the ease of operating with oil, the certainty of results and the ease with which the present coal burning furnaces can be adopted to the oil burning appliance, places oil as a fuel upon nearly an equal footing with coal. This is a fact that the manufacturers will see, hence we may look for the salesmen with oil burning appliances to receive more than the usual attention.

We may see oil smoothing out the coal troubles of many in the near future, a fact which will be welcomed by the fire-room employees, for with the use of oil as fuel comes a lessening of the back-breaking kind of work heretofore analogous to firing with coal.

At the present time there are insurance restrictions placed upon the use of oil, which in a measure have a restraining influence upon its use, but with the demand will spring up a means of surmounting such minor details.

* This editorial from the August 1902 *Practical Engineer* is almost as timely today as it was 44 years ago when it was written. At that time the use of oil was in its infancy—there were even restrictions against its use. Oil has helped but it has not solved the coal problem—that, like the poor, is still with us.

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XUM

How Electrical Machines Function—Part 1

Here is a very simple article explaining how electric motors and generators work . . . In this first part the author discusses the various forms and units of energy, how they are related and how they are associated in the operation of motors and generators . . . He also explains magnetism and how it is made use of in motor and generator design. This first part is confined to a discussion of elementary principles. Part II to be presented in a subsequent issue will consider direct current motors and generators while Part III will be devoted to a general discussion of alternating current motors and generators

By R. ANDRIESSEN

Electrical Engineer, Crocker-Wheeler Electric Manufacturing Co.

THIS ARTICLE in intended to explain the principles on which the operation of d-c and a-c motors and generators is based and how the various types differ from each other. Although some statements may not be entirely accurate from a purely scientific standpoint, a practical picture of the operation will be given.

It will be necessary to discuss a few laws of physics before going into the various types of machines individually. The first point to be discussed is the question of energy.

Energy

Energy may be defined as the ability to perform work. It may be said that there are four kinds or four forms of energy:

1. Thermal energy
2. Chemical energy
3. Mechanical energy
4. Electrical energy

Within broad limits it is possible to change any of these types of energy into any other type of energy. For instance, consider the chemical energy which is contained in coal. This chemical energy is released when the coal is burned—which is a chemical process combining the carbon of the coal with the oxygen of the air. In a boiler this energy is transferred to the steam in the form of thermal energy or heat energy. In a steam engine this heat is converted into mechanical energy available at the shaft. This mechanical energy is changed into electrical energy in a generator and is available at its terminals in the form of kilowatt hours. In a motor this electrical energy is changed back into mechanical energy which again becomes available at the shaft.

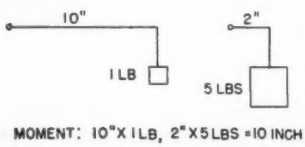

Fig. 1. The pulling force in lb multiplied by the length of the arm is called the "moment"

There is a law which states that there is just so much energy available and this amount cannot be changed. It may be changed from one form into another but is is impossible to add or to subtract from its total quantity. This means that all losses which must be accepted when changing from one type to another are not really losses at all. They are really energy which is changed into some other form of energy (like heat in a bearing) which cannot be usefully employed at that time. This is one of the most important laws of physics and can aid in understanding many things which otherwise are difficult to visualize. The important point from the standpoint of this discussion is that a generator, dynamo or alternator changes mechanical energy into electrical energy and that a motor, whether it be a synchronous motor, an induction motor or a d-c motor changes electrical energy into mechanical energy. The great advantage of the electrical form of energy is that it can easily be transported, in the form of an electrical current conducted over wires.

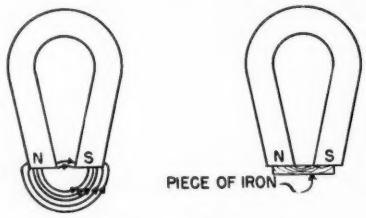

Fig. 2. Horseshoe magnets

Units

Of great importance in every day life, as well as in industry, is the question of units. When it is necessary to discuss a property such as length or cubic contents, it will be difficult to do unless there is some way of comparing one length with another length. In order to be able to do this, units have been assigned to the different properties. For instance, the unit of value in this country is the dollar. Because this is of the utmost importance, a unit will be defined as follows:

> "A unit is an arbitarily selected quantity of any property; the extent to which anything possesses that property is then expressed in multiples or parts of that arbitrarily selected quantity."

For instance, if something is 3¾ in. long, it only means that this length contains three times plus three-fourths the length of the arbitrarily selected unit of length, the inch. Sometimes there are several different units for the same property, such as inches, feet, yards, miles, etc. for length. This, however, is only done for convenience sake. It is obviously easier to speak of something being one mile long than to say that it is 63,360 in. These units have definite relations with respect to each other and any quantity can be easily expressed in any other of these units, as long as the relation, which is called the conversion factor, is known.

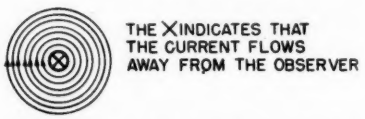

Fig. 3. Magnetic lines of force around a wire carrying a current

When considering the various properties connected with electricity, certain units, arbitrarily selected, must be assigned, to explain how much of such property is available. Since electricity or electric energy cannot be seen, it is not easy to visualize these electrical properties. In order to understand them better, a comparison of the flow of electric current to the flow of water through a pipe can be used. The pressure which exists at the pipe inlet, which is called the "head" in hydraulics, can be compared to the voltage, the unit of which is called the volt. This is the unit of electrical pressure. The rate at which the water flows through the pipe can be compared to the flow of electric current, for which the ampere has been selected as the unit. It will require more pressure to force a certain quantity of water through a pipe in the same period of time when the pipe is reduced. In the same way, when the wire size becomes smaller, more electrical pressure or volts will be required to force a certain quantity of electric energy through the wire, or to cause a certain number of amperes to flow in the wire. The property which makes this greater voltage necessary is called the electrical resistance of the wire; the ohm has been arbitrarily selected as its unit.

There are two closely related concepts which are frequently confused. These two are electric energy and electric power. In order to explain the difference between them, our water comparison can be used again. Consider a

barrel containing a certain quantity of water. This quantity of water can be compared to an amount of electric energy. By the previous definition, energy is the ability to perform work. In order to empty the barrel a lot of water can be drained over a short period of time or a small amount of water over a longer period of time. When the amount of water drained in one unit of time is multiplied by the length of time during which the water is drained, the result will always show the same total quantity of water. If the quantity of water is compared to the amount of electric energy, then the rate at which the water is drained can be compared to the electric power. If a certain amount of electric energy is available, it can be used in the form of electric power for a certain length of time. If twice as much power is used, then it will take only half the length of time before the same amount will be used up.

The unit which has been selected for electric power is the watt or kilowatt which is 1000 units. Another unit used is the horsepower which is equal to 746 watts. A generator is generally said to have a capacity of so many kilowatts, while motors are said to have a capacity of so many horsepower. When one kilowatt of electric power is used over a period of one hour's time, an amount of energy called one kilowatt hour will be have been used up. If two kilowatts are used over a period of one-half hour, the energy used will still be one kilowatt hour of energy. If a 50 watt lamp is used it can burn for:

$$\frac{1 \text{ kwh}}{50 \text{ w}} = \frac{1000 \text{ watt hours}}{50 \text{ watts}} = 20 \text{ hours}$$

before one kilowatt hour of energy is consumed.

The thing to remember is that electric power is the rate at which electric energy is used per unit of time, and that a given job can be done quickly with a lot of power or more slowly with less power.

There are some fundamental relations between these electrical units. For instance, the resistance multiplied by the current will equal the voltage; the voltage multiplied by the current will equal the power, and the power multiplied by the length of time during which it is used will give the energy that is consumed. The details of these relations form the basis of electrical engineering and of necessity fall outside the scope of this discussion. It is necessary only to understand and remember the concepts and the meaning of the units.

Another very important concept that is rather difficult to define is torque. Torque may be said to be the twisting effort, in other words, that property which makes the rotating part of a motor turn around.

Since it is rather difficult to visualize torque, it may be better to explain it by means of an example. Suppose a nut is to be tightened on a stud, in order to fasten an object to the bedplate of a milling machine. First this nut is turned by hand until it is reasonably tight. When it becomes impossible to turn it any further, a wrench is used and it becomes possible to tighten the nut considerably more. If this is still not tight enough a piece of pipe is slipped over the wrench and the pull is then exerted on the end of this pipe. The length of this pipe can actually be extended until it becomes possible to strip the thread.

The principle involved is the lever-arm principle. The distance from the center of the nut to the point at which the pull is exerted is called the arm. The twisting effort becomes greater, the longer the arm is on which the pull is exerted; it will also be greater, the larger the pulling force is that is applied. The effort is therefore equal to the pulling force expressed in pounds multiplied by the length of the arm expressed in inches or feet; the unit for this effort, which is technically called a "moment," is for this reason the foot pound. See Fig. 1.

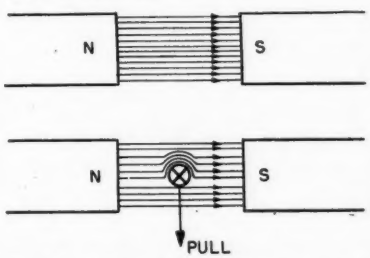

Fig. 4. Diagram showing how a force is exerted on a current-carrying wire placed in a magnetic field

The torque of a motor is the twisting moment which the rotor exerts. It will be readily understood that the torque will be the greater, the higher the horsepower of the motor is. It will not be so readily understood, but is nevertheless true, that the torque will increase when the speed of the motor decreases and will decrease when the speed of the motor increases. For this statement to be true it is necessary that the same amount of power, expressed in horsepower, is transmitted regardless of the speed. The relation between horsepower and torque is given by the relation:

$$\text{Torque in ft lbs.} = \frac{\text{Horsepower} \times 5250}{\text{Revolutions Per Minute}}$$

On the basis of the preceding explanation it can now be understood that for a given horsepower and a given speed the pull in a belt running on a motor pulley will be large when the pulley is small and correspondingly smaller when the pulley diameter is increased.

One more point that is worthy of discussion is the "load." It is obvious that a motor or generator will not always be operated at its full rating. A motor on a machine tool will supply power which varies with the speed and feed of the cutter. Sometimes it will supply its rated horsepower; at other time it will be supplying only a part of this value. A generator which supplies light for a factory will supply during daylight hours only a fraction of the electric power which it must supply at night when all the lights are turned on. The rating of such a generator must naturally be based on the maximum amount of power it may be asked to supply.

The motor rating in horsepower and the generator rating in kilowatts are therefore only the maximum values that the apparatus can supply under specified conditions without overheating, while the load is the amount of horsepower or amount of kilowatts which the machine is actually supplying at any given moment. The rating of those machines, therefore, is a constant value, while the load varies continually. However, the units in which they are expressed are the same.

Magnetism

Everybody at sometime in his life has seen or owned a small horseshoe magnet. It is known that when a piece of iron is held near enough to this magnet it will be attracted thereto. In other words, this magnet exerts a force on the piece of steel. This magnet is known as a permanent magnet—that is, it is magnetized and remains that way for a long time. The way the physicist pictures this is that a number of magnetic lines come out of one end of the magnet, called the north pole, and re-enter the other end, the south pole. When there is no piece of iron present these lines pass from one end to the other through the air and the air opposes the passage of those lines with a certain amount of resistance. Now the amount of resistance offered by iron and some other materials is much less than that which the air offers and the reason why this piece of iron is attracted to the magnet is that these lines attempt to follow the path of least resistance. (Fig. 2).

Electrical engineers have found a way to produce this magnetism. Some types of material will retain the magnetism once they have been subjected to it, while other materials can be magnetized but lose their power as soon the magnetizing agent is removed. To distinguish these two, the first mentioned is called a permanent magnet, the latter an electromagnet.

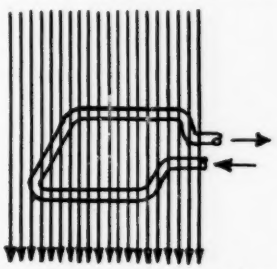

Fig. 5. Here the wire of Fig. 4 is bent into the form of a loop or coil

An example of an electromagnet may be seen in many industrial plants, where electromagnet are used to pick up steel and scrap.

The way in which this magnetism is produced is by winding a number of

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turns of copper wire around the iron part to be magnetized. When an electric current is caused to flow through this wire, the iron inside the coil will be magnetized and will remain magnetic until the current is interruped.

This may be explained by saying that a magnetic field, that is a number of magnetic lines, is produced by the turns of wire around the iron. The lines of force, as they are called, will enter the iron part and magnetize it. However, these lines of force or this magnetic field will be set up by the current as it flows through the turns of copper wire regardless of whether the iron is present or not. Magnetic fields are utilized in many applications such as electric relays, electric brakes, clutches and chucks.

It is not necessary that the wire is wound in turns, although it happens that that is the most logical way for making iron parts magnetic. A magnetic field will always exist around a wire which carries an electric current. We may think of this as a number of concentric circles with the wire at the center; these concentric circles may then be thought of as magnetic lines. It should be remembered that these magnetic lines themselves stand still with respect to the pole which produces them; however, they exert an influence on a magnetic pole which enters their range of effectiveness. This pole will be forced around the wire if it is free to move; the direction can be predetermined. The illustration shows these magnetic lines around a copper wire and the arrows indicate the direction in which a magnetic north pole will be forced when the current in the wire flows away from the observer, that is, into the paper. (Fig. 3).

At this point it is well to recall that two different magnetic fields have now been discussed.

1. A field which exists between two poles of a magnet;
2. The field around a wire carrying an electric current.

The first mentioned can be visualized by means of magnetic lines in the direction from the north pole to the south pole and the latter as circular lines around the wire.

When such a current-carrying wire with its magnetic field is placed in a magnetic field between two poles, these two fields will react on each other. In the space below the wires, the lines around the wire will counteract the lines between the poles. Above the conductor, the lines around the wire and the lines between the poles act in the same direction and will support each other. The result is that there will be a crowding of the lines above the conductor and a greater or lesser absence of lines below the conductor. If these lines are imagined to be rubber bands which have a tendency to straighten themselves out, then it becomes obvious that a force is exerted on this wire in a downward direction. This is actually the case; it may be summarized by saying that a force will be exerted on a current-carrying wire when it is placed in a magnetic field. (Fig. 4).

Instead of this single wire through which a current flows, consider what happens when this wire is bent in the form of a loop or of a coil. (Fig. 5). A certain number of magnetic lines will pass through the inside of this loop. It has been found that when the number of lines which pass through this loop is changed in some way that a certain electrical pressure, or voltage, will be created between the ends of the loop. Of, if the ends of the loop are connected together, then a certain amount of electric current will be caused to flow through the wire. This is called "electro-magnetic induction" and will be found to be of great importance when the method of operation of motors and generators is discussed. There are three ways in which the number of lines that pass through the loop can be changed. In the first place, it is possible to change the number of lines between the poles by strengthening or by weakening the poles. In the second place, it is possible to move the poles, together with their magnetic field, and leave the coils stationary. Finally, it is possible to move the coil out of the sphere of influence of the poles. It has been established that the amount of electrical pressure or voltage between the ends of the loop is not only influenced by the change in the number of lines, but also by the speed with which this change takes place. The greater the change is, the greater the voltage will be and the faster the change, the greater the voltage will be. Because the resistance of the wire does not change, the voltage is produced in the loop (technically called the voltage which is induced in the coil) will cause a current to flow when the loop is closed; this current will depend on the same factors in the same way as the voltage.

This concludes the discussion of the elementary physical principles which are involved in the operation of motors and generators. The ways in which these principles are applied in building motors and generators will be discussed under the headings of the different types of apparatus in subsequent articles.

SOOT ON THE BLADES CAUSED FAN VIBRATIONS

By John F. Slavinsky

IN THE MANY years of my work in the power game I have rarely ever seen any new installation that was put into service without some sort of kinks to iron out, whether it is a boiler or turbine or accessory. When we installed our 60,000 lb per hr steam generator and got the plant operating to our satisfaction much to our chagrin we received a petition from the local authorities complaining that noise was keeping our neighbors awake nights.

After tracing the complaints we did find out that about a block away the sound of the forced draft fan was the cause of the complaints.

As we got nearer the plant the noise was not so loud and it did not disturb the neighbors that resided close to the plant.

The forced draft fan was a constant speed machine, connected through a coupling to a 50 hp motor which was rotating at 3600 rpm. The draft was controlled by the automatic controls from the instrument panel by operating an air piston to the dampers.

To eliminate this noise we had to build a room around the fan with insulating blocks and that seemed to make every one happy for the moment. Everything seemed to be under control until one afternoon the fireman ran into the engine room and asked the engineer on watch what made the boiler room shake so much. After looking things over we found that the induced draft fan was vibrating so much that the vibrations were transmitted through the supporting columns down to the firing floor.

When the heavy day load dropped off, late in the afternoon, we took the cover off the fan housing and found some of the fan blades had a scaley deposit on them. We bumped the fan a couple of times with a block of wood and this seemed to knock off this deposit, which was nothing more than baked-on soot. The soot, we found, formed only on certain parts of the fan and threw the machine out of balance, hence the vibrations.

After starting up the fan again it ran quietly for a few days and the same thing happened over again. We repeated the same temporary cleaning performance and got the machine back in service, after which we made a thorough study of this condition and found a solution to eliminate this trouble.

The first thing we did find was that the firemen were blowing the economizer tubes with steam that was not dry enough. In other words, the lines to the soot blowers were not drained thoroughly and every time the soot blower opened up a slug of water was shot into the passages. The fan then picked up part of this damp soot which clung to the fan blading.

To eliminate this trouble, which was partly the fireman's fault for not draining out the condensate properly, we drilled a small ⅛ in. hole at the bottom of the soot blower line and let it drain into the ash pit. This way the line was constantly draining from the time the steam to the soot blower line was open until the valve was shut off.

The next step was to install an air jet on the fan housing to blow air through a ⅜ in. nozzle. When the fireman got through operating the soot blowers after coming on watch he then went up to the fan and blew off the blading with the jet air. Since this addition to the soot blowing procedure we had no more vibrations from our induced draft fan.

WHAT UNITS SHOULD YOU USE IN REPORTING BOILER WATER TESTS?

By URBAN C. FLEMING, JR.

Chemist, Gas & Electric Department, City of Holyoke, Mass.

Results in parts per million most satisfactory practice . . . But for various reasons many engineers want to use grains per gallon . . . This article makes a clear comparison of the units and size of sample required . . . Shows limits for tests on lime-soda effluent expressed in these different units.

Dealing with the question of units used in reporting results of boiler water and feedwater tests it may be said that the expression of results in parts per million appears to be the most satisfactory practice.

However, for the benefit of those engineers who may use different units and methods of testing (with regard to the size of the water sample) I shall attempt to make a clear comparison of the different units and also indicate the proper limits for the tests on the effluent from the lime soda softener expressed in different units.

Lime Soda Softener Effluent

TABLE I

Alkalinity Tests

Acid used—N/50 sulfuric acid

Size of sample—50 cc sample of lime soda softener effluent.

Hardness Test

Soap solution—Standard soap solution (1 cc = 1 mg $CaCO_3$)

Size of sample—50 cc sample of lime soda softener effluent

(A) Hydroxide alkalinity (2P — MO) = OH

	Value of 2P — MO in cc of N/50 sulphuric acid	Parts per million of Hydroxide alkalinity expressed as $CaCO_3$	Grains per U.S. gallon of Hydroxide alkalinity expressed as $CaCO_3$
Lower Limit	0.5	10.0	0.583
Upper Limit	1.0	20.0	1.166

(B) Carbonate alkalinity due to excess soda ash = 2(MO — P) — H

	Value of 2(MO — P) — H in cc of N/50 Sulphuric acid	Parts per million of carbonate alkalinity due to soda ash expressed as $CaCO_3$	Grains per gallon of carbonate alkalinity due to excess soda ash expressed as $CaCO_3$
Lower Limit	1.0	20.0	1.166
Upper Limit	1.5	30.0	1.749

When N/50 sulfuric acid is used in the alkalinity tests and standard soap solution (1 cc = 1 mg $CaCo_3$) is used in the hardness test and when the size of the sample is 50 cubic centimeters the following relationships hold true:

Cubic centimeters × 20 = parts per million

Cubic centimeters × 1.166 = Grains per gallon (U.S.)

The relationship between grains per gallon (U.S.) and parts per million is as follows:

Grains per gallon × 17.15 = parts per million

Parts per million × 0.0583 = grains per gallon.

When a 58.3 cc sample of water, commonly called the U.S. miniature gallon, is used, the limits that should be maintained, for the hydroxide alkalinity and the carbonate alkalinity due to excess soda ash, in the effluent from a lime soda softener are indicated in the following table:

TABLE II

Alkalinity Tests

Size of sample—58.3 cubic centimeters of effluent lime soda softener.

Acid used—N/50 sulfuric acid.

Hardness Test

Size of sample—58.3 cubic centimeters of effluent from lime soda softener.

Soap Solution—Standard Soap Solution (1 cc = 1 mg. $CaCO_3$).

(A) Hydroxide alkalinity = 2P — MO

	Value of 2P — MO in cc of N/50 sulphuric acid	Parts per million of Hydroxide alkalinity expressed as $CaCO_3$	Grains per U.S. gallons of Hydroxide alkalinity expressed as $CaCO_3$
Lower Limit	0.583	10.0	0.583
Upper Limit	1.166	20.0	1.166

In this case:

Cubic centimeters × 17.15 = Parts per million.

Cubic centimeters × 1.0 = Grains per gallon.

(B) Carbonate alkalinity due to excess soda ash = 2(MO — P) — H

	Value of 2(MO — P) — H in cubic centimeters	Parts per million of alkalinity due to excess soda ash expressed as $CaCO_3$	Grains per U.S. gallons of carbonate alkalinity due to excess soda ash expressed as $CaCO_3$
Lower Limit	1.166	20.0	1.166
Upper Limit	1.749	30.0	1.749

"Okay, now once more—and try and pay attention to what you're doin'!"

Maintenance of Industrial Electronic Equipment—V

Switches, their construction and operation . . . Checking of switches . . . Cleaning and lubrication of switches . . . Transformers and choke coils applications . . . Maintenance of transformers . . . Importance of checking for cleanliness . . . Rheostats and potentiometers . . . Maintenance of rheostats . . . Terminal blocks and meters . . . Pilot lights . . . Maintenance of rotating equipment

By WESTINGHOUSE ELECTRONICS COMMITTEE

MANY DIFFERENT types of switches will be encountered in electronic equipment. There are toggle switches, circuit breakers, microswitches, interlock switches, gang switches and pushbutton switches. For purposes of maintenance, the switches used may be further classified in two general groups: Those whose contacts are readily accessible and those whose contacts are completely enclosed. The basic maintenance operations of inspection, cleaning and lubrication are chiefly applicable to circuit breakers, gang switches, limit switches and pushbutton switches. The enclosed construction of the toggle switches, microswitches and interlock switches limits preventive maintenance to inspection and cleaning. Maintenance work on switches includes inspection, tightening, cleaning and lubricating.

Inspect the mechanical action of each switch and, while doing so, look for signs of dirt or corrosion on all exposed elements. Where contacts are readily accessible, it will be necessary to examine the element of the switch visually. Where the contacts are enclosed and not accessible, such as toggle and interlock switches, the action of the switch is checked by slipping the toggle or pressing the switch button and noting the freedom of movement, as well as the amount of spring tension.

The safety and interlock switches should be checked visually by noting their action as the doors open or the panel is moved. **In some cases, the switches may be out of alignment and fail to operate, endangering the lives of the personnel and damaging the equipment.**

Examine gang switches to see if the contacts are clean. As inspection is visual, do not pry the leaves of the switch apart. The movable blades should make good contact with the stationary member, and as the former slides into the latter, a spreading of the stationary contact leaf should be seen.

Tighten loose mountings and connections. Increase tension of a spring only when the inspection indicates that adjustment is necessary. Do not attempt to adjust the mechanism of the circuit breakers.

If the inspection shows that any terminals, connection or section of the switch is dirty, corroded or pitted, clean the part by using a dry, clean cloth. If the condition is more serious, moisten the cloth with cleaning fluid and rub vigorously. Surfaces that have been badly corroded should be cleaned with fine sandpaper. The same maintenance procedure applies to switch contacts as to relay contacts. Surfaces which have been touched by the bare hands must be thoroughly cleaned with a cloth moistened in cleaning fluid, and then polished with a clean, dry cloth. The points that contact the moving blades are naturally the ones that most often show signs of wear. Examine these points carefully to see that both sides of each blade, as well as the contact surfaces of the clips, are clean at all times. When the exterior surfaces of switches are dirty, clean them with a stiff brush moistened with cleaning fluid, and polish with a piece of cloth.

If binding is noted during inspection of a switch, apply a drop of machine oil with a toothpick to the bearing surfaces. Do not allow oil to run into the electrical contact as a film of oil may cause serious damage or poor contact. Lubrication of switches is not recommended unless serious binding is noted. Lubricants should never be applied to the contact surfaces unless recommended in the instruction book supplied with the equipment. A lubricant should be applied only when it is needed.

Transformer and Filter Chokes

Transformers and choke coils used in electronic apparatus have several applications, but generally they can be divided into high potential and low potential units. Normally, the transformers and chokes are enclosed in a metal housing and are impregnated with an insulating compound. Almost without exception, defective transformers and chokes must be replaced but preventive maintenance techniques give some amount of protection against failures at inopportune times. Work on transformers and filter chokes includes feeling, inspecting, tightening and cleaning.

Maintenance of Transformers

As soon as power has been removed from the apparatus and the circuit grounded, maintenance can be started. Feel all accessible transformers and chokes. If they are abnormally warm, steps should be taken to determine the cause of the overheating.

Carefully inspect each transformer or choke for general cleanliness, for tightness in connection of mounting brackets and rivets, for solid terminal connections, and for secure connecting lugs. The presence of dust, dirt and moisture between terminals of the high-voltage transformers and chokes may cause flashovers. In general, overheating in wax impregnated transformers or coils is indicated by the presence of the insulating compound on the outside or around the base of each coil or around the base of the unit. If this condition is encountered, steps should be taken to immediately localize the trouble. Inspect the exposed windings for breaks and frayed insulation.

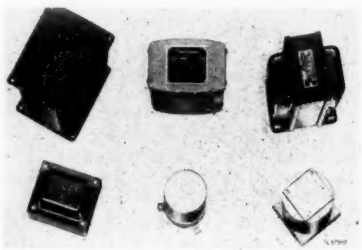


Fig. 12. Typical transformers and filter chokes are shown in this photograph

Tighten all loose mounting screws or connections immediately. The placement of the wires carrying high voltages in the unit is very critical and must not be disturbed except in cases of emergency. If it is absolutely necessary to remove wires in order to tighten loose parts, note the position of the wires before disconnecting them, for they must be restored to their original position.

The cases on the transformer and choke coils are easily cleaned with a dry cloth. In a few instances it may be desirable to use a cleaning fluid as a solvent to remove foreign matter. Corroded contacts or connections can be sandpapered and wiped clean. Corrosion on ground connections must be removed and the connections resoldered.

Rheostats and Potentiometers

Most rheostats and potentiometers fall into two main groups for maintenance purposes: 1) Those that are constructed in such a manner that the resistance winding and sliding contacts are open and accessible; 2) those that are so constructed that the inner parts are totally closed. In the latter group, very little maintenance can be performed since opening and removing the metal case will do more harm than good. Work on the rheostats and potentiometers includes inspecting, tightening, cleaning, adjusting and lubricating.

Inspect the mechanical conditions of each rheostat and potentiometer.

The arm should be keyed tightly to the shaft, and the shaft should turn easily in the bushing which supports it. See whether the bushing is cracked or broken. Poor contact between arm and resistor winding is caused by insufficient tension in the arm. If the shaft is positioned by means of a spring, the spring should be inspected for breakage. Also, inspect the assembly and mounting screws, set screws and nuts. Examine the in-

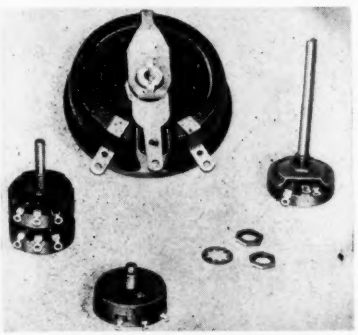


Fig. 13. Rheostats and potentiometers are pictured above

sulated body of the rheostat for dust, dirt, cracks or chipped places. Inspect all metallic parts for dust, dirt and corrosion. Tighten all loose assembly or mounting screws. Generally, the heads of the mounting screws are easily accessible, being located on the front panel, one on each side of the control knob. In a few cases, the screw head is covered by the knob, and it is necessary to remove the knob for tightening. When tightening a potentiometer take care not to move it.

Clean the contact surface of the resistance winding, the sliding contact, the body of each rheostat, and potentiometer, and connections whenever they are found to be dirty or corroded. Take care not to move the rheostat or potentiometer setting when cleaning.

If the contact surfaces are corroded, clean with crocus cloth. The body of the rheostat or potentiometer may be cleaned with a brush or cloth. If the contact point of the sliding arm is burned or pitted, it is good practice to fold a piece of crocus cloth between the contacts and the windings; then, slide the arm over the crocus cloth a number of times to remove the scar. Do not exert undue pressure on the wire when cleaning it as damage may result. If cleaning fluid has been used, wipe all parts to remove the light film which remains after the fluid evaporates.

Adjust the tension in the contact arm to insure positive contact. Use a pair of long nose pliers to spring the arm slightly in the direction in which increased tension is desired. Do not make a sharp bend in any one place, but work the pliers along the length of the contact arm and put a slight bow in it. Be careful not to damage the windings.

The contact surfaces of rheostats and potentiometers are lubricated with a very thin film of petrolatum. When binding or squeaking is noticed, one or two drops of machine oil, applied at the bearings with a toothpick, will be sufficient. Since the slightest flow of oil into the windings or the sliding arm contact may cause serious damage, apply lubricant very carefully and only in the bearings. Wipe off any excess oil.

Terminal Blocks

Terminal blocks are used as connecting and distributing points for electrical circuits. Their construction is simple and in most cases they consist of a strip of insulation with connections already mounted. Little preventive maintenance is required on terminal blocks.

Inspect the terminal boards or blocks for cracks, breakage, dirt and loose connections and mounting screws.

Carefully examine the connections for mechanical defects, dirt and corrosion.

Tighten all loose screws, lugs and mounting bolts. When tightening screws, be sure to select a screwdriver of the correct size, and do not exert too much pressure.

Clean the terminal board with a dry brush. If a connection is found to be corroded or rusty, clean thoroughly with crocus cloth or a cloth moistened with cleaning fluid. Then wipe the board with a dry cloth. Where connections have been loosened to remove dirt or corrosion, make certain that the connection is replaced properly so that it makes a good electrical and mechanical connection.

Meters

Meters are extremely delicate instruments and must be handled very carefully. They require very little maintenance. They are precision instruments and cannot be repaired unless adequate facilities are available. A damaged meter should be replaced with a new meter and the original meter returned to the instrument repair department or to the factory for repair.

Inspect the leads and connections to the meters. Look for loose, dirty or corroded connections; also, for cracks, and broken cases or cover glass. Since the movement of a meter is extremely delicate, its accuracy will be extremely affected if the case or glass is broken, and dirt and moisture filters through. If the climate is damp, it would be a matter of only a short time until enough moisture comes through the cracks to ruin the meter.

Tighten all loose connections. Any loose meter wiring should be inspected for dirt or corrosion before it is tightened. The tightening of meter connections requires a special technique as careless handling can easily crack the case. To prevent breakage, hold firmly the retaining nut which makes contact with the meter case, while the outside nut is being tightened. This permits the tightening of the connection without increasing the pressure on the head of the stud inside the meter case.

Meter cases are generally made of hard, highly polished phenolic material and can usually be cleaned with a dry cloth. If cleaning is difficult, dampen the cloth with a cleaning fluid. Dirty connections may be cleaned with a small stiff brush or a piece of cloth dipped in the solvent. It should be emphasized that solvents do not entirely remove dirt from hard surfaces. Some of the dirt will be left in a softened state and must be removed with a clean cloth.

Corroded connections are corrected by sanding them lightly with a very fine grade of sandpaper. After cleaning, wipe the connections with a clean cloth.

Most meters, except pyrometers and some special applications, will indicate zero when the equipment is shut down. The procedure for setting a meter to zero is not difficult and requires only a screwdriver—the thinnest one available. Before adjusting the meter, tap the case lightly with the tip of one finger to help the needle overcome the friction that sometimes exists at the bearings and prevents an otherwise normal unit from coming to rest at zero. If adjustment is needed, insert the tip of the screwdriver in the slotted screw head (located below the meter glass) and slowly turn the adjusting screw until the pointer is at zero. Pyrometers should indicate the temperature at the thermocouple and, when open circuited, should read ambient temperature at the location of

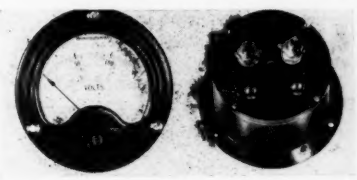


Fig. 14. Front and rear view of a typical meter is shown in this photo

the pyrometer except in cases where surpressed zero instruments are used. Take the following precautions:

1. Do not attempt to make a zero adjustment for several minutes after shutdown in order to allow time for the needle to settle to its resting place.
2. View the meter face and pointer "full on" not from either side.
3. Avoid turning the screw too far, because the needle may be bent or the hair spring damaged.

Pilot Lights

Pilot lights are used to indicate that power has been applied to a circuit or that a circuit is ready for power to be applied. Their construction is simple and they are easily removed.

Inspect the pilot light assemblies for broken or cracked pilot light jew-

XUM

els, loose bulbs, bulbs with loose bases, loose mounting screws and loose, dirty or corroded connections. If necessary, make temporary repairs on broken or cracked pilot light jewels, joining the broken pieces with a narrow piece of cellophane or friction tape. Replace damaged lights, also broken or burned-out pilot bulbs as soon as possible. While the removal of a bulb may sometimes be difficult, the process is usually simplified if a small piece of friction tape is folded over the top of the bulb and pressed from two sides. After the tape is attached, unscrew the bulb and remove from the socket. A new bulb can be replaced with the fingers, but if the bulb sticks, use friction tape as a grip.

Tighten any loose mounting screws and resolder any loose connections. If connections are dirty and corroded, they should be cleaned before soldering. Tighten each bulb into its base. Clean the pilot light jewel, screw the base assembly, and the glass of the bulb with a dry cloth.

Clean corroded socket contacts or corroded connections with a piece of cloth. Grime on the connections of the socket contacts may be removed with a piece of cloth or a small brush dipped in cleaning fluid. The surfaces are then polished with a dry cloth. Clean contacts are important in pilot lights because of the low voltage at which they operate.

Rotating equipment such as motors, generators, blower motors require scheduled maintenance in order to keep them in good operating condition. The three principal causes that contribute to faulty operation of this type of equipment are accumulation of dirt, dust or other foreign matter on the windings and moving parts of the equipment; lack of sufficient lubrication of the bearings and other moving parts; and improper adjustment or imperfect condition of the moving parts. Given proper maintenance, motors and generators will give long and efficient service. If they are neglected, they fail. The instructions on their care are intended to prevent or forestall unexpected failures. Work on the motors and generators includes feeling, inspecting, tightening, cleaning and lubricating.

The cabinets which house electronic equipment are treated to resist corrosion. If this surface treatment is broken it should be repaired. The work on the cabinet includes inspecting, cleaning and lubricating.

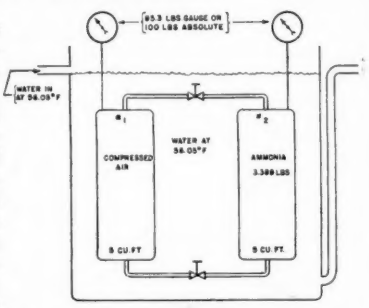
Inspect the outside and inside of each cabinet thoroughly, paying strict attention to every detail. Check the door hinges, the ventilator mountings and the panel screws. Inspect the panels for loose knobs, switches, etc.

Clean the interior and exterior with a clean, dry cloth. Use cleaning fluid if necessary. Dull crackle finish paint can also be cleaned with a few drops of light machine oil on a soft cloth. Make certain that the oil is rubbed in and that all excess oil is removed,

BOYLE, DALTON AND GRAHAM

To the Editor:

SOME TIME ago the writer was asked to conduct a question and answer program before a group of engineers. My job on this assignment was to supply questions that would create discussion; one of the problems which I posed was theoretical and was used to illustrate the application of a fundamental law in physics. I was surprised to find that out of those present—and there were a number that I considered good engineers—only one would commit himself on the subject and he very emphatically disagreed with me.



This sketch illustrates the equipment set-up in this problem

As there is a possibility that I erred in my logic I thought that it would be interesting to read comments and criticisms from the readers of POWER PLANT ENGINEERING on this subject.

MILTON W. SHAFFER

This is the problem:

This theoretical problem illustrates an application of Dalton's Law, a knowledge of which is necessary for an understanding of many problems in engineering. Let us assume that there are two steel vessels each with a volume of 5 cu ft. These are connected by piping and valves as shown in in the sketch. Both vessels are submerged in a tank of water maintained at a temperature of 56 F by constant circulation. The connecting valves are assumed to be closed.

Vessel No. 1 is charged with compressed air to a pressure of 100 lb absolute. The No. 2 vessel is charged with a quantity of ammonia and at the 56 F temperature its pressure is also 100 lb absolute. The charge of ammonia that would go into the No. 2 vessel is the amount that would be sufficient to charge both vessels at the 56 F temperature with saturated ammonia with no ammonia left unevaporated.

At the 56 F temperature 1 cu ft of saturated vapor weighs 0.3388 lb. As the total volume of the two vessels is 10 cu ft (neglecting the volume of the connecting pipes and valves) the amount of ammonia charged in the No. 2 vessel would be 10×0.3388 or 3.388 lb.

The question is: What would take place and why would it take place under the conditions outlined here if the two valves connecting one tank to the other were opened?

Par. 1. To better explain what takes place let us assume that we have the conditions as outlined in the No. 1 vessel, i.e.: air at 100 lb abs. But in No. 2 vessel we have a vacuum. Now were we to open the connecting valves on the two lines the pressures would equalize and we would have a pressure of 50 lb abs in each vessel. (The pressure varies inversely as the volume if the temperature remains constant—Boyle's Law).

Par. 2. Now, again assuming that we have No. 2 vessel charged with 3.388 lb of ammonia and in No. 1 a vacuum. Were we to open the connecting valves there would be a drop in the pressure, the unevaporated portion of the ammonia would completely evaporate, extracting the necessary heat from the water, the pressure would again rise to 100 lb abs corresponding to the 56 F water. This would be in accordance with the properties of the refrigerant.

Now getting back to the original problem; were we to open the valves connecting the two vessels there would be a gradual mixing and diffusing of the air and ammonia gas in the two vessels. This would take place slowly and in accordance with the Law of Graham regarding the diffusion of gases. In a problem of this nature consideration must be given to another law known as Dalton's Law which is stated in one text book as follows: "Each gas or vapor in a mixture at a given temperature contributes to the observed pressure the same amount that it would have contributed had no other gas or vapor been present." With this law in mind and referring back to Par. 1 we note that the final pressure in the two vessels when considering that only the air was present, was 50 lb abs. We found in Par. 2 that the final pressure, considering only the ammonia as being present, was 100 lb. abs. Applying Dalton's Law we find that the final pressure would be 50 lb due to the air, 100 lb due to the ammonia, or a total pressure of 150 lb abs.

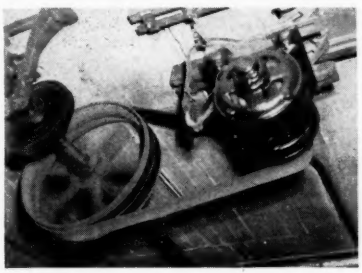
Editor's Note—An excellent example of the application of Dalton's Law to the solution of engineering problems is provided in Sabin Crocker's answer (POWER PLANT ENGINEERING, *page 109, October, 1946*) *to Question 346 regarding vent valves.*

PRACTICAL HINTS AND KINKS

PIVOTAL BASE DRIVE SOLVES THE PROBLEM

By C. C. Hermann

A LOT OF TROUBLE with bearings, belt and in fact the whole drive shown in the accompanying photograph was experienced prior to changing to the pivotal base set-up. The drive center-to-center was about 48 in. using a 5 hp motor and a 6 in double-ply belt. The driven arrangement was a machinery line shaft located under a balcony so



This photograph shows the arrangement of the pivotal base for the motor

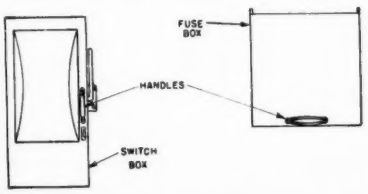
that to elongate the drive would involve projecting the motor section out into space with special construction for support.

Instead of going to the more expensive and unsightly construction the millwright installed a pivotal base under the motor. Thereafter the drive worked perfectly and the saving in belting, bearings and general maintenance attention was conservatively estimated as paying for the change in three months time.

HANDLES FOR SWITCH BOXES

By Thomas Trail

SOME SWITCH BOXES are not equipped with handles on the door to open them by. A light handle of the type used on screen doors is satisfactory for small switch boxes and can easily be attached



Drawings showing the attachment of light handles to switch boxes

to the door. Larger switch boxes require larger handles such as are used on heavier doors.

Such handles are also convenient on hinged covers of fuse and pull boxes, since the original handles on these covers are usually very weak and pull loose easily.

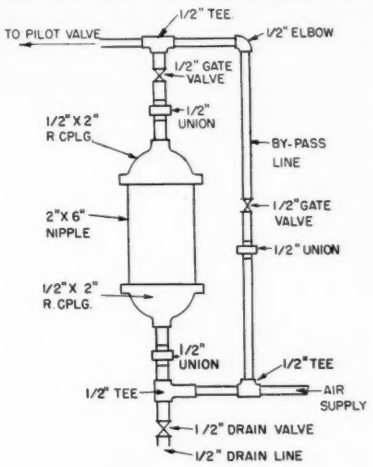
HOME MADE AIR FILTER

By John F. Slavinsky

DURING THESE days of material shortages an engineer has to be on his toes and from time to time make use of the material he has in stock around the plant.

In our plant we use quite a few air lifts—air to regulators, etc. In spite of the face that our air intake has a filter, the constant pulsation of the air intake loosens fine particles of dust which enter the air lines. When this dust reaches some distant regulator it is bound to make the pilot valves operate sluggishly, sometimes causing them to stick.

Once this happens the regulator has to be put on hand control while the pilot valves are taken out of service and cleaned. This, of course, takes some time and while operating on hand con-



Home Made Air Filter

trol the operation of the equipment is very erratic.

Recently we had an occasion where we had to have a filter in a hurry. With the knowledge that deliveries were difficult fresh in our minds, we decided to make our own filter from materials on hand in our stock room.

The entire job from the selection of material to the construction of the filter took less than 2 hours.

The best delivery on a purchased filter was 4 weeks. After using this home-made filter for several days we found it highly satisfactory and have decided to use it continually and forget about buying a replacement.

The material needed was ordinary pipe fittings (see sketch). The inside of 2 in. nipple was filled with steel wool and as a stop we used two pieces of fine mash wire cut out to fit—one at the top and one piece at the bottom to keep the steel wool in place.

STACK CANNON

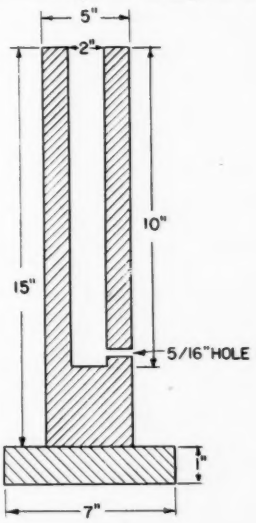
SOOT CLOGGED stacks present a problem for the engineer who must concern himself with the mess at periodic intervals or suffer the baneful effects of reduced draft.

This chore can be done speedily and economically by means of a "Stack Cannon" that uses black powder to jar the soot accumulation down into the breeching where removal is convenient.

The diagram is indicative of the type of cannon that may easily be turned out in the machine shop from salvage stock such as old shafting, steel billets, etc. The small hole near the base is used to insert the "squib" or fuse to ignite the charge.

Electrical squibs are recommended where temperatures are high and time fuse would be seriously affected by the heat. These squibs can be purchased from practically any vendor in explosives and are fired safely by means of a standard dry cell. The method of loading is accomplished by pouring the barrel to within 2 in. of the top with FFF black powder after the squib is inserted. This is followed by a wad of tissue paper approximately ½ in. thick and is followed by filling the remaining space with well tamped wet clay. Tight tamping is the secret of the operation since unless the powder is well confined the explosion is weakened.

The described charge is ample for stacks measuring up to 100 ft in height and may be used safely in steel, lined or unlined brick or tile stacks. Usually one charge is ample



Stack Cannon

to loosen the average soot accumulation but in obstinate cases three to four shots may be required. The small wires of the squib may be led through the crevice at the base of the breeching door; the door is closed, the battery posts are applied to the wire ends, and the blast is off.

Oak Ridge, Tenn. P. C. ZIEMKE

XUM

How To Determine The Proper Charge For a Blind Refrigeration System

This short article based on an actual case in which nearly all of the original ammonia charge in a refrigeration system has been lost, tells exactly what to do and how to charge a refrigeration system with ammonia without scales or other means of measuring the refrigerant

By GEORGE HOLMAN

A FEW DAYS AGO I was called upon to service a small commercial refrigerator of two tons capacity, which I had installed six years ago. I found nothing basically wrong at the compressor. But the butcher in charge of the unit complained that one of the two finned-type evaporators frosted up badly. Although he defrosted the evaporators daily, frost and ice refilled the interstices between the fins and tubes of this particular evaporator. This reduced the quantity of air circulating through it, and seemingly was the cause of a lower than normal suction pressure. The compressor ran noisily and almost continuously at pumpdown inefficiency.

The frosted evaporator was located 10 ft from a vertical downcomer to the compressor manifold. The second and unfrosted evaporator was located 20 ft around the wall from the first. Frost showed well downstream from the thermostatic expansion valve, but did not clog the fins or tubes.

Our course, the trouble was not at the frosted evaporator or its expansion valve. Apparently, the trap of the thermoexpansion valve of the second evaporator had filled with scale or sludge, or the distributing nozzle had been partly closed by corrosion. When long in service, a distributing nozzle tends to become etched or furred by corrosion inside the passage. This surface condition provides a primer for gradual deposition of hardened sludge. This sludge is generally a mixture of metal scale, litharge, hydrocarbon compounds formed by disintegration of lubricating oil and other impurities inert to the alkaline action of ammonia.

Clogging due to ice at the expansion valve is rare in ammonia charged systems. Although loss of power charge concurrent with slight leakage past the needle seat of the valve produces the same effects as a partly clogged orifice or distributing nozzle, that is, lower suction pressure, frost for a distance along the evaporator inlet pipe and increased running time, I have found that clogging of the nozzle is the more frequent cause.

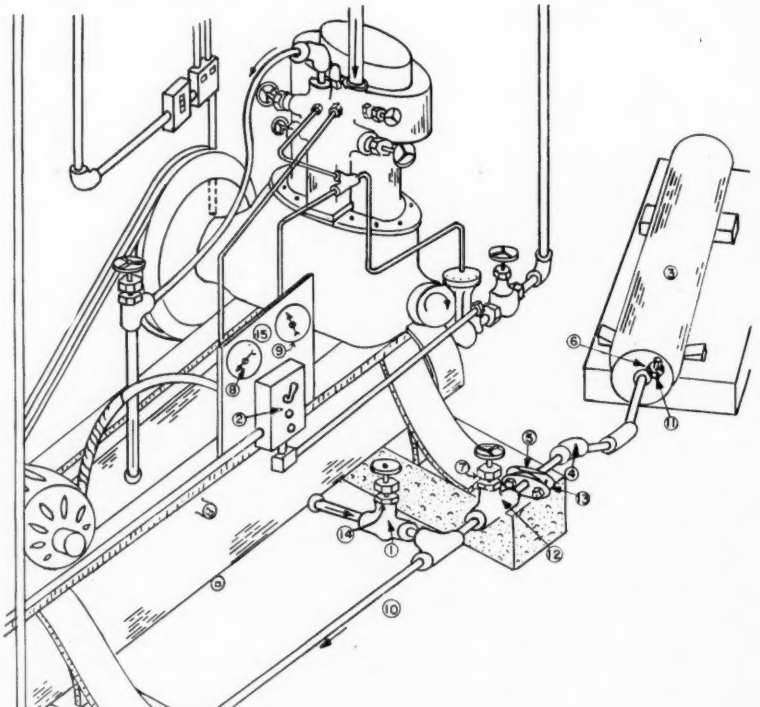
When servicing this outfit, I was astonished to learn that the box was to be held at 34 F instead of the 38 F the prints called for. At 15 psi suction pressure, and even with forced circulation, finned type evaporators are prone to ice up at 34 F. This is especially likely if the load is heavy, the off cycle short and the box door fanned enough to produce excessive air change in humid surroundings.

In accordance with the prints, I had wired the evaporator fans to start and stop as the temperature controller started and stopped the compressor. At the lower box temperature, however, it was apparent that the finned evaporators would frost up rapidly. To make defrosting easier, I had slotted the cover plate of a pull box in the conduit to the temperature controller, and placed a toggle switch in the box. I led the controller circuit through this toggle and connected the fan motors through it to a live phase at open main contactor. All the butcher had to do to defrost was flip the toggle button. The compressor stopped. But as long as the mercury switch of the controller remained closed, the evaporator fans kept on running. This was a much quicker method of defrosting than idling the whole system by opening the line switch.

The evaporators were anchored to the ceiling, and faced opposite directions for better air circulation. They were top fed, with branch lines rising 6 inches from the liquid line to the thermoexpansion valves. No accumulator had been provided for in the plans. To provide compressor protection I had raised the return line to half the height of the evaporation, and run branch lines up to that level to connect them in horizontally.

This arrangement prevented liquid from running down the return line into the compressor cylinders, should an expansion valve leak during a long off cycle. As long as both evaporators did not flood simultaneously, there was no danger of liquid boiling over into the compressor. The ratio of evaporator and return line volume to compressor displacement did not permit a too rapid suction pressure fall, with accompanying violent ebullition of any liquid in the evaporators, at start of the off cycle. Since the evaporators could contain the whole system charge, priming of the compressor was possible only if leakage occurred during an overcharge.

In spite of the heavily frosted evaporator, no liquid expanded back to the



Drawing showing steps used in charging the refrigerating system

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compressor manifold. A later test of the suction gage proved that its 8 psi reading was 10 psi too high. Actually, the system was operating with evaporators under 4 in. vacuum. At the moment, however, I had to accept the gage reading at its face value. I judged the job to be one of cleaning the thermoexpansion valve of the unfrosted evaporator. Since compressor speed was constant, stoppage at this valve would account for all the visible phenomena—lower suction pressure, long operating cycle and frosting of the lone evaporator left in service.

There is usually enough liquid ammonia between the distributing nozzle of a thermoexpansion valve and its upstream stop valve to render the air in a small storage room unbreathable for several minutes. It cannot be readily pumped out through a stopped up expansion valve. To get rid of this nuisance quantity very rapidly, it must be backed out by leaving the stop valve open and putting the liquid line under low pressure, preferably a vacuum.

The enclosed horizontal shell and tube condenser beneath the compressor had no liquid gage glass. To check on the system charge, it was necessary to use the frost test on the condenser. This is best done by draining the water out of this vessel and reversing the flow of refrigerant at the compressor manifold. Under 35 psi pressure, or less, frost will appear on the condenser shell approximately to the level of the liquid refrigerant in it.

I did not trouble to drain the condenser, but only shut off the water. When I opened bypass and pumpout valves, evaporator pressure rose to 85 psi, while condenser pressure fell to 80 psi. When I had closed suction and discharge valves, the machine valves clattered faintly on their seats. Vapor was blowing through them from the apparent 80 psi of the condenser into the apparent 85 psi of the evaporators. Since this was an obvious impossibility, one of the gages was in error. Closing the lines at the set-screw cocks and checking the gages at atmospheric pressure revealed the 10 psi heavy reading of the suction gage. I reset this gage by pulling and replacing the pointer.

On starting the compressor, the frost melted from the first evaporator and from the downstream flanges of both thermoexpansion valves. But no frost had formed on the condenser shell when the suction gage read only 15 psi. At first I attributed this to the water in the condenser tubes. Water used for condensing gives up a great deal of heat in falling to 32 F, and may give up still more heat by freezing to the tube walls, if there is enough liquid ammonia to vaporize and absorb it. Frost on the condenser shell is delayed by this heat. Frost on the liquid line, if the master stop valve is left open, should not be delayed.

Under these conditions lower pressure in the condenser causes flash vapor to form in the higher parts of the liquid line. The pressure of this vapor, plus the backward flow of vapor through the expansion valve, though slight, assists the flow of liquid back into the condenser. In this instance flow was assisted by gravity.

The condenser pressure fell much too rapidly. When frost failed to form on the liquid line at 10 psi in the condenser and 105 in the evaporators, I stopped the compressor and opened the discharge stop valve. Hot vapor from the evaporators soughed sonorously as it flowed back into the empty condenser. This sound is as distinctive as a shout in a darkened house, and proves the same thing. The condenser was empty and the system short of ammonia. During six years of operation most of the original 50 lb charge had been lost.

How to Charge the Refrigerant Without Overcharging

The best set-up for charging ammonia into a system is to place the flask on a floor scales and connect it by high pressure flexible metal hose to the charging valve. The refrigerant can then be measured into the system pound for pound. If too much is charged, a specific amount can then be drawn out.

But I had neither scales nor flexible connections when I went back to charge this system a few days later. I had only a flask containing what I knew was too much ammonia, an 8 in. crescent wrench, two 14 in. stillsons, litharge, glycerin, some test papers and some pipe fittings. With this equipment and the two pressure gages I faced the problem of charging the system adequately without overcharging it. Here is how I did the job:

I closed the master liquid stop valve (1) and started the compressor at the manual button (2). While the evaporative side of the system was being pumped down, I laid the flask of ammonia on a box nearly level with the charging connection. I tilted the valve end of the flask downward by blocking up the opposite end. Then I wedged the flask to keep it from rolling (3).

With three long pipe nipples, two 45 degree connections and a female flange, I made up a connection (4). The two 45's permitted me to correct the flange to fit the charging connection without moving the flask or putting any strain on the pipe. I put a litharge-glycerin paste on the threads, but lacked an approximate half-turn of screwing the joints as tight as for permanent installation. I removed the blind flange of the charging connection. I dipped a new gasket in compressor oil, fitted it into the connection flange and bolted the two flanges pressure-tight against it (5).

I fitted the crescent wrench to the flask valve stem and gave it a quarter turn. The connection joints were good, for no smell of ammonia appeared. I gradually opened the valve until it shouldered against the bonnet (6). By this time the system had pumped down to 10 in. vacuum, and light frost showed on the liquid line. This frost melted, and liquid gurgled into the system as I opened the charging valve (7).

Had I throttled either the flask valve or the charging valve at this time, frost would have appeared on the liquid line, but not on the flask. Such frost would have been due to these valves acting as expansion valves. Its disappearance is not due to the flask being empty. Meltage may occur if the throttled valve is opened wide enough to eliminate expansion. Or, meltage of the frost may take place if the expansion valves at the evaporators close enough to permit the pressure in the liquid line to build up above 50 psi.

The time required for frost to form on the flask depends upon the suction pressure, capacity of the expansion valves, volume and heat transfer capacity of the evaporators, compressor displacement per minute, size of the flask and whether or not flask and charging valves are opened widely. If the system has a large volume, a high heat transfer rate, is well pumped down to a high vacuum, and has ample compressor capacity, frost may form on the bottom of a small flask within a few minutes after flask and charging valves are opened widely.

If refrigerant flow is restricted by any means, however, such as expansion valve orifice or nozzles being very small, low heat transfer capacity of the evaporators, limited compressor capacity or high suction pressure, frost may not form on the flask at all. In its stead beads of moisture often collect, and freeze when the flask is emptied under vacuum.

Since this system could not hold all the ammonia in the flask, I could determine when this system was fully charged only by watching the "creep" of the discharge gage pointer. This creep of the pointer during charging is due to one or both of two causes. There are appreciable non-condensable gases in the system; or there is an overcharge of refrigerant. With the master valve closed, liquid collects in the condenser and submerges the lower tubes. This concentrates the non-condensable gases into the smaller gas volume of the condenser, and raises their pressure, which is indicated by the gage. If no gases are present in the system, submergence of part of the tubes reduces the amount of heat transfer surface until the capacity of the condenser is less than that of the compressor (9).

On finding very little air in the system, I permitted a 5 psi creep, then shut the flask valve (11). Since the flask has not been emptied, no frost had appeared on the liquid line (10). But now the frost appeared. When the suction gage indicated 10 in. vacuum, I closed the charging valve (12). I removed the flask connections and replaced the blind flange (13). I opened the master liquid stop valve (14) and watched the gages until the suction pressure rose to normal (15). With only a faint odor of ammonia, the system was properly charged.

LETTERS AND COMMENTS

WHAT'S AN ENGINEER?

THE LONG and much discussed subject, Engineers vs Professionals is one that should be settled and since I am one of the pinchbars that keeps the wheels of industry from stopping and have no sheep skin that entitles me to the exalted title of a Professional, I would like to get this matter off my chest once and for all, and I feel that we of the Pinchbar title should have some voice in the final naming of the two classes of Engineers.

1st: I want to say that there is a class distinction between the sheep skins and the fellow who has not grown a skin. To my way of thinking, engineers who have not had the opportunity of being sent off to college to get their sheep skin by which they can use the title, "Professional," are not entitled to any more than what the word Professional implies. Neither do I think that the person who gets a college diploma has a right to the title of Engineer without practical experience. No one will be so foolish as to trust his engine to a student who has not had actual experience, therefore I say that there is a difference and a very great difference between the engineer and the professional, and this difference should be recognized in the titles given to the two classes of service. After a student of engineering has had the years of experience required to be an engineer he should have it tacked on to his Professional degree, and not until then. Neither should the engineer have the title of Professional until he can prove by actual examination that he can pass the theoretical requirements for the title of professional.

2nd: Let's not make the grand mistake of giving too much credit to professionals and get the foolish idea that professionals are the only ones who are going to make it economically possible to keep industry going on high priced everything. To design an engine or machine and to figure out what it will do, and to get the engine to perform as expected are jobs requiring different skills.

The man who goes to a technical college and emerges with his diploma as an engineer is no more an engineer than a medical school graduate is a doctor until he has had years of experience. He will get more sleep while he is getting his experience than the non-professional and if he is able to apply his technical training he will get there sooner, especially if he has a few engineers around to tell him how things actually work.

I would like to see this matter settled on some equitable basis and the deciding done by an equal number of engineers and professionals.

If there is to be a distinction, and I have said there should be, it should be done on the basis of ability to earn as well as to learn.

I have worked with a good many professionals in my life and while I do not wish to discredit the boys who come out of school, I want to stress the fact that, in my opinion, not one of these student engineers will ever earn his professional pay until he has been on the job under an experienced engineer for 3 to 10 years. When you can take over a job as superintendent of a bunch of large power plants or a large industrial plant, run your business and meet a large payroll and save your employer more than you are earning, then and then only will you be entitled to the full title of Professional Engineer, or better Engineer Professional. The man that pays the bills cares nothing about your diploma. He is interested in your ability to produce.

I do not want to leave the impression that technical knowledge is not an advantage to most of the engineers without college training. So many men are today keeping the wheels of industry moving without the benefits of a college degree, and so many of these men are the pioneers and foundation of our present progress in engineering, that it seems unfair to start chiseling on them with such an unfair and unreasonable charge that they are not entitled to carry the title of engineer. Men of this type were engineers before college titles were ever thought of and there are literally thousands of us who can run rings around some of the professionals with our experience and home study. We do not want to have any part of our titles taken away. We feel that we should have the professional tacked on if we are able to fairly compete with the fellow who got his in college, and we don't want any hocus-pocus examiners on the job either. If we can deliver the goods and can prove it, that is all that should be necessary to keep things straight on the records.

Lake Linden, Michigan. J. B. LINKER

KEEPING A 20-YEAR OLD COMPRESSOR OPERATING

By John F. Slavinsky

FOR THE PAST twenty years we have been operating two 750 cu ft air compressors, alternating their operation every week. These machines are belt driven by 50 hp motors. Other than cleaning valves which is a routine job and taking up on bearings from time to time, their performance has been excellent. A few weeks ago our No. 2 compressor developed a loud pounding noise. After changing over compressors we checked the machine that we had just down. The bearings were OK, crank and cross-head adjustments were of proper fit. We started up the compressor again. After listening and looking around we saw that the belt-driven pulley, which is 4 ft in diameter, had a wobble in it.

At first we thought that the leather belt which was driving the machine caused this knock. After closer inspection while compressor was in motion we saw that the cast iron compressor pulley had shifted toward the compressor and was striking the concrete compressor foundation. We shut the machine down, loosened the hub bolt and shifted the pulley back to its original position on the shaft, after which we put the compressor back on the line. It ran fine for about three days and the trouble started again. This time we knew where to look for the trouble. Again we shut down the machine and repeated the same operation. Only this time we put lock nuts on both ends of the hub bolts and nicked the shaft so that the compressor pulley would not slip off its set position. We tightened up the hub bolt with a wrench and 3 ft piece of pipe on the end with two men pulling up tight on the nut. After putting machine back into service it still persisted in wobbling very slightly.

As we needed the services of this machine badly we left her on the line the way it was. I wrote to the manufacturer's service engineer asking for advice. After about a week he paid me a visit and asked to see the compressor.

I took him in tow and showed him how badly the machine performed and after "hemming and hawing" about it a few minutes he finally arrived at the conclusion that it was something he never saw before and he had no way of helping me out. After talking about it a little more he suggested that I purchase a newer and more efficient machine. I asked him how long I would have to wait to get one and the best his company could do was 1 year delivery. Finally after talking a bit more he left. Finally I decided to take the bull by the horns. After thinking things over I figured if the pulley stayed on for 20 years it should stay on for another 20 years.

After ordering a new set of bearings (which I had to wait for about 3 weeks) we took the old main bearings out, took the pulley off the crank shaft and went to work. First we installed the new bearings. The old ones weren't too bad. This time we also inspected the key and hub key way. We saw that the key edges were rounded, after putting the pulley back on the shaft we decided to use a new key slightly over size.

After making up the hub tight, it ran as smooth as the day the machine was first put into operation.

It seems that the hub which is split on one half had taken a slight stretch and the larger key had taken up this loose fit.

WORK SCHEDULES

AFTER READING some of the work schedules submitted by Mr. Parks and others, I still like the one we are using here in our plant. Not only is management satisfied but also the employees.

We have used this schedule from the time the NRA started. The only change that has been made is the schedule of the "A" man. After the "A" man worked Monday and Tuesday instead of returning to work on a Wed-

nesday night, he expressed a desire to return that same (Tuesday) night with just an eight hour rest period. That gave him a 3 day off period every fourth week. This schedule is not the conventional 40 hr work schedule. The man on the C shift works a 48 hr week with time and a half for the extra eight hours.

The men work three weeks at 40 hr per week and one week at 48 hr. This way there is hardly any confusion and every one is satisfied. This schedule of ours may be of some help to readers of POWER PLANT ENGINEERING.

JOHN F. SLAVINSKY

SANDERSON'S WORK SCHEDULES

HERE ARE two 5-day 40-hour week work schedules that we use in the boiler room and compressor room of our plant and which have worked out very well. The boiler room schedule is set up so that each man works five consecutive days on each shift, with days off between all shifts except the 4 to 12 and 8 to 4 shifts.

Finishing one shift at midnight Saturday and starting another at 8 a.m. Sunday is a disadvantage, but the men don't complain because Sunday is a quiet day in the plant and this doubling up enables them to have four consecutive days off before the next shift.

After the third week is finished the schedule repeats. The two relief men work the same hours every week and are indicated on the schedule only to show their existence.

Each man works only five days each week under the compressor room schedule, but he works six or seven consecutive days on each shift. The relief man on the 12 to 8 shift on Wednesdays is the relief man from the boiler room. No two men are partners for more than a week at a time under the schedule.

Note that the shift shown on the left hand margin is for the beginning of the week and that shown on the right hand side is for the balance of the week, the days off being the dividing line.

Chicago, Illinois M. SANDERSON

WHAT'S WRONG IN THIS REFRIGERATION PLANT?

THE FOLLOWING comment is offered on the contribution of Siegfried Ruppright, Los Angeles, in the September issue of POWER PLANT ENGINEERING entitled "What's Wrong in this Refrigeration Plant?"

In his answer to the question "Why is —20 to —30 F desired?" he explains that "A temperature of —10 F will keep practically everything indefinitely." This statement is badly out of focus with the known facts of food technology.

Quick frozen foods are held at from 0 to —10, but *not* indefinitely. This is prohibited by law in some states.

It is well known that to retain vitamin content in frozen foods requires not only a constant temperature of zero or below but also constant humidity. Vegetables must be blanched before freezing to arrest enzyme action later in storage which will cause loss in vitamin content. Blanching in steam or hot water destroys the tissues, de-aerates the commodity to be frozen and arrests respiration.

Recent investigations have shown that certain quick frozen commodities appear to re-generate enzyme action after some months of storage at sub-zero temperatures. Competent investigating authorities have shown that green beans, for example, stored for 12 months at —5 F lose 47 per cent ascorbic acid. Strawberries frozen in syrup and stored at 0 to —10 F for six months lost 70 per cent ascorbic acid.

Authorities in food chemistry recommend that the maximum period for meat storage should not exceed 12 months at —10 F.

Regarding the use of electric heater in meat storage to prevent the appearance of slime as referred to in the article I do not believe that Mr. Ruppright will find any experienced food plant managers resorting to such practice. Modern practice is to properly insulate cold storage rooms and to control the humidity by keeping the spread between the air of the room and the temperature of the evaporating refrigerant at the required minimum.

The Use of Booster Compressors

Mr. Ruppright, in commenting on the use of the booster compressor says, "Select that one of your compressors which has the proportionately largest valve area and the smallest valve-disc weight." I wonder if the author of this recommended practice has actually attempted to operate the standard compressor as a booster in low temperature service. If so, how did he treat the shaft stuffing box or rod packing to prevent the entrance of air into the system when such a compressor was operated at subatmospheric pressures, say at absolute pressures corresponding to 12 or 15 in. vacuum?

Mr. Ruppright is rather vague in his treatment of a "flash tank." Does he refer to the well known liquid and gas cooler used in connection with booster compressors?

Oil Traps

Mr. Ruppright says that "All compressors should have oil traps directly returning to the crank case." I wonder if he has ever opened the crank case of an enclosed ammonia compressor and examined the effect on bearings, including crank pins, wrist pins and cylinder walls of such unfiltered oil blown direct from the high pressure oil trap into the crank case. Ask any builder of

COMPRESSOR ROOM ENGINEER'S WORK SCHEDULE

Name	Watch	Sun.	Mon.	Tues	Wed.	Thur.	Fri.	Sat.	Watch
				WEEK BEGINNING JULY 7					
Able	8 to 4	on	on	on	on	on	off	off	8 to 4
Baker	4 to 12	off	off	on	on	on	on	on	4 to 12
Charles	4 to 12	on	on	off	off	on	on	on	12 to 8
Dunn	12 to 8	on	on	on	off	off	on	on	8 to 4
Relief	12 to 8	..	..	..	on	..	..	..	
				WEEK BEGINNING JULY 14					
Dunn	8 to 4	on	on	on	on	on	off	off	8 to 4
Able	4 to 12	off	off	on	on	on	on	on	4 to 12
Baker	4 to 12	on	on	off	off	on	on	on	12 to 8
Charles	12 to 8	on	on	on	off	off	on	on	8 to 4
Relief	12 to 8	..	..	..	on	..	..	..	
				WEEK BEGINNING JULY 21					
Charles	8 to 4	on	on	on	on	on	off	off	8 to 4
Dunn	4 to 12	off	off	on	on	on	on	on	4 to 12
Able	4 to 12	on	on	off	off	on	on	on	12 to 8
Baker	12 to 8	on	on	on	off	off	on	on	8 to 4
Relief	12 to 8	..	..	..	on	..	..	..	
				WEEK BEGINNING JULY 28					
Baker	8 to 4	on	on	on	on	on	off	off	8 to 4
Charles	4 to 12	off	off	on	on	on	on	on	4 to 12
Dunn	4 to 12	on	on	off	off	on	on	on	12 to 8
Able	12 to 8	on	on	on	off	off	on	on	8 to 4
Relief	12 to 8	..	..	..	on	..	..	..	

Note: Time shown on left hand margin is beginning of week.
Time shown on right hand margin is balance of week.

BOILER ROOM ENGINEER'S WORK SCHEDULE

Name	Watch	Sun.	Mon.	Tues.	Wed.	Thur.	Fri.	Sat.
				WEEK BEGINNING JULY 7				
Allen	8 to 4	on	on	on	on	on	off	off
Brown	4 to 12	off	off	on	on	on	on	on
Carter	12 to 8	off	off	on	on	on	on	on
	Relief	4–12	4–12	off	comp. room 12–8	off	8–4	8–4
	Relief	12–8	12–8	off	off	off	8–4	off
				WEEK BEGINNING JULY 14				
Brown	8 to 4	on	on	on	on	on	off	off
Carter	4 to 12	off	off	on	on	on	on	on
Allen	12 to 8	off	off	on	on	on	on	on
	Relief	4–12	4–12	off	comp. room 12–8	off	8–4	8–4
	Relief	12–8	12–8	off	off	off	8–4	off
				WEEK BEGINNING JULY 21				
Carter	8 to 4	on	on	on	on	on	off	off
Allen	4 to 12	off	off	on	on	on	on	on
Brown	12 to 8	off	off	on	on	on	on	on
	Relief	4–12	4–12	off	comp. room 12–8	off	8–4	8–4
	Relief	12–8	12–8	off	off	8–4	8–4	off

enclosed crank case commercial ammonia compressors if they recommend this practice. This method of oil recovery was discarded years ago in the ice and cold storage industry.

The author also comments that when the compressor pumps too much oil the compressor must be overhauled and that eventually oil rings must be used. He also says a thicker oil may be needed. The fact of the matter is, that all vertical single acting compressors are fitted with oil rings below the compression rings, in the lower section of the pistons.

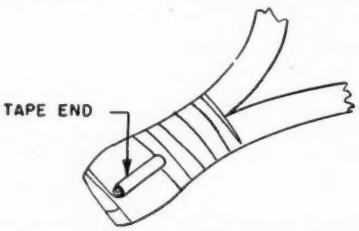
Compressor lubricating oil should be selected on the basis of the required congealing and vapor point for any given operating evaporating and discharge temperature and not with the idea of making a seal between worn cylinder walls and worn rings.

Atlanta, Ga. C. T. BAKER,
Consulting Engineer

TAPED SPLICE

By Thomas Trail

WHEN TAPING A SPLICE, roll back the end of the friction tape as shown in the accompanying figure. This will make it easy to locate the end of the



Drawing showing method of taping a splice

tape later if it becomes necessary to open the splice, thus saving time in hunting for the tape end which may be difficult to see because of poor light.

Questions And Answers

Question No. 356

HOW FIGURE OIL QUANTITIES FOR VARIOUS TEMPERATURES AND GRAVITIES?

I HAVE A problem some of the Q & A readers can help me with. That is, how is oil figured per pound under the various temperatures and specific gravities?

The way I figured this out was as follows: From Kent's Handbook, the increase in volume per degree rise in temperature is, 0.0004. As the oil is purchased at a temperature of 60 F, its weight is 8 lb per gallon. The temperature at the oil meter is 150 F. There is a difference of 90 deg F. $0.0004 \times 90 = 0.036$. $8 \times 0.036 = 0.288$. I assumed this was the decrease in weight due to the 90 deg temperature difference. Then: 8 lb $-$ 0.288 $=$ 7.712 lb as the actual weight per gallon, for 150 F at the heater. Assuming 520 gal per hr was burned, $520 \times 7.712 = 4010.24$ lb per hr.

For the gallons per hour, at 150 F, corrected to 60 F, 520 gal $\times$ 0.036 $=$ 18.72 gal increase in 520 gal. 520 $-$ 18.72 $=$ 501.28 actual gal at 60 F. At 60 F the weight is 8 lb. Then, $501.28 \times 8 = 4010.24$ lb. per hr. I would appreciate any information I can get from other readers.

West Roxbury, Mass. C.V.E.

Another figure given by Kent is that oil expands I per cent per 25 F increase in temperature. However, Marks (p 298, 4th Ed.) gives three different mean values for the coefficient of cubical expansion (a) as follows:

Petroleum, Pennsylvania	0.50
Petroleum, California	0.43
Petroleum, Texas	0.43

It is assumed that C.V.E. has determined in some way that his oil weighs 8 lb per gallon at 60 F, or has received that information from the oil supplier. This weight corresponds approximately to an API gravity of between 15 and 16, according to Table II.

Another table in Marks (page 805, 4th Ed.) gives the following:

Degrees API	Coefficient of Cubical expansion Per degree F
Less than 15	0.00035
15 to 34.9	0.0004
35 to 50.9	0.0005
51 to 63.9	0.0006
64 to 78.9	0.0007
79 to 88.9	0.0008
89 to 93.9	0.00085
94 to 100	0.0009

Suppliers of fuel oil can, and usually do give data to users on the API gravity and temperature at which they measure the oil. The easiest way to convert measurements of oil weights and volumes is by means of tables and curves calculated from the various relations of API gravity and specific gravity agreed upon by the industry.

Table I is a volume correction table for petroleum oils. If API gravity at 60 is between 15 and 34.9 use the group 1 table. For such oil, multiply the number of gallons measured at temperature t by the multiplier M to find the number of gallons at 60 F.

In the above example, if 520 gal per hr of API gravity 16 oil were burned,

Table 1—Volumetric correction table for petroleum oils. (Fuels and Fuel Burners by Steiner; pages 181, 182; McGraw-Hill Book Company)

t = observed temperature in degrees F

M = Multiplier for reducing oil volumes to basis of 60 F

Group 0 applies to fuel oils of API gravity at 60 F up to 14.9; Group 1 to gravity from 15.0 to 34.9, Group 2 to gravity from 35.0 to 50.9

t	M	t	M
Group 0			
0	1.0211	155	0.9674
5	1.0194	160	0.9657
10	1.0176	165	0.9640
15	1.0158	170	0.9623
20	1.0141	175	0.9606
25	1.0123	180	0.9590
30	1.0106	185	0.9573
35	1.0088	190	0.9556
40	1.0070	195	0.9539
45	1.0052	200	0.9523
50	1.0035	205	0.9507
55	1.0017	210	0.9490
60	1.0000	215	0.9474
65	0.9982	220	0.9458
70	0.9965	225	0.9441
75	0.9948	230	0.9425
80	0.9931	235	0.9409
85	0.9914	240	0.9392
90	0.9896	245	0.9376
95	0.9879	250	0.9360
100	0.9862	255	0.9344
105	0.9844	260	0.9328
110	0.9827	265	0.9312
115	0.9809	270	0.9296
120	0.9792	275	0.9280
125	0.9775	280	0.9264
130	0.9758	285	0.9248
135	0.9741	290	0.9233
140	0.9724	295	0.9217
145	0.9707	300	0.9201
150	0.9691		
Group 1			
0	1.0242	30	1.0120
5	1.0222	35	1.0100
10	1.0202	40	1.0080
15	1.0181	45	1.0060
20	1.0161	50	1.0040
25	1.0140		

t	M	t	M
Group 1—(Continued)			
55	1.0020	155	0.9628
60	1.0000	160	0.9608
65	0.9980	165	0.9590
70	0.9960	170	0.9570
75	0.9940	175	0.9551
80	0.9921	180	0.9532
85	0.9902	185	0.9513
90	0.9881	190	0.9494
95	0.9861	195	0.9476
100	0.9841	200	0.9457
105	0.9822	205	0.9438
110	0.9803	210	0.9419
115	0.9783	215	0.9401
120	0.9763	220	0.9382
125	0.9744	225	0.9363
130	0.9724	230	0.9345
135	0.9705	235	0.9326
140	0.9686	240	0.9307
145	0.9667	245	0.9289
150	0.9647		
Group 2			
0	1.0297	80	0.9901
5	1.0273	85	0.9876
10	1.0248	90	0.9851
15	1.0223	95	0.9826
20	1.0198	100	0.9802
25	1.0174	105	0.9776
30	1.0149	110	0.9752
35	1.0124	115	0.9727
40	1.0099	120	0.9702
45	1.0074	125	0.9677
50	1.0049	130	0.9652
55	1.0025	135	0.9627
60	1.0000	140	0.9603
65	0.9975	145	0.9578
70	0.9951		
75	0.9925		

Table II—Specific gravities at 60/60 F corresponding to degrees API and weights per U. S. Gallon (Mechanical Engineers' Handbook; Marks; 4th Ed.; page 85; McGraw-Hill Book Co.)

[Calculated from the formula, specific gravity = $\frac{141.5}{131.5 + \text{Deg. A. P. I.}}$]

Degrees A. P. I.	Specific gravity	Lb per U. S. gallon	Degrees A. P. I.	Specific gravity	Lb per U. S. gallon	Degrees A. P. I.	Specific gravity	Lb per U. S. gallon	Degrees A. P. I.	Specific gravity	Lb per U. S. gallon
10	1.0000	8.328	33	0.8602	7.163	56	0.7547	6.283	79	0.6722	5.595
11	0.9930	8.270	34	0.8550	7.119	57	0.7507	6.249	80	0.6690	5.568
12	0.9861	8.212	35	0.8498	7.076	58	0.7467	6.216	81	0.6659	5.542
13	0.9792	8.155	36	0.8448	7.034	59	0.7428	6.184	82	0.6628	5.516
14	0.9725	8.099	37	0.8398	6.993	60	0.7389	6.151	83	0.6597	5.491
15	0.9659	8.044	38	0.8348	6.951	61	0.7351	6.119	84	0.6566	5.465
16	0.9593	7.989	39	0.8299	6.910	62	0.7313	6.087	85	0.6536	5.440
17	0.9529	7.935	40	0.8251	6.870	63	0.7275	6.056	86	0.6506	5.415
18	0.9465	7.882	41	0.8203	6.830	64	0.7238	6.025	87	0.6476	5.390
19	0.9402	7.830	42	0.8155	6.790	65	0.7201	5.994	88	0.6446	5.365
20	0.9340	7.778	43	0.8109	6.752	66	0.7165	5.964	89	0.6417	5.341
21	0.9279	7.727	44	0.8063	6.713	67	0.7128	5.934	90	0.6388	5.316
22	0.9218	7.676	45	0.8017	6.675	68	0.7093	5.904	91	0.6360	5.293
23	0.9159	7.627	46	0.7972	6.637	69	0.7057	5.874	92	0.6331	5.269
24	0.9100	7.578	47	0.7927	6.600	70	0.7022	5.845	93	0.6303	5.246
25	0.9042	7.529	48	0.7883	6.563	71	0.6988	5.817	94	0.6275	5.222
26	0.8984	7.481	49	0.7839	6.526	72	0.6953	5.788	95	0.6247	5.199
27	0.8927	7.434	50	0.7796	6.490	73	0.6919	5.759	96	0.6220	5.176
28	0.8871	7.387	51	0.7753	6.455	74	0.6886	5.731	97	0.6193	5.154
29	0.8816	7.341	52	0.7711	6.420	75	0.6852	5.703	98	0.6166	5.131
30	0.8762	7.296	53	0.7669	6.385	76	0.6819	5.676	99	0.6139	5.109
31	0.8708	7.251	54	0.7628	6.350	77	0.6787	5.649	100	0.6112	5.086
32	0.8654	7.206	55	0.7587	6.316	78	0.6754	5.622			

The weights in this table are weights in air at 60 F with humidity 50 percent and pressure 760 mm.

measured at 150 F at the heater, then at 60 F there would be 520 × 0.9647 = 501.64 gal. The weight in pounds at 60 F would be the gallons at 60 F times the weight per gallon at 60 F from Table II, or 501.64 × 7.989 = 4007.6 lb.

A convenient method of obtaining approximate specific gravity at any temperature for a given API gravity is shown on the attached chart.

It should be explained that in the vernacular of the petroleum industry, "specific gravity" is the ratio of the weight of a unit volume of oil to the weight of an equal volume of water. (One gallon of oil occupies the same volume as one gallon of water but weighs a little less). "Gravity" on the other hand is the degrees API equivalent. The weight-volume relationship is that originally devised by Baumé, in recent years standardized by the American Petroleum Institute, and now known as degrees API.

$$\text{Deg API} = \frac{141.5}{\text{Specific gravity } 60/60 \text{ F}} - 131.5$$

Specific gravity 60/60 F means the

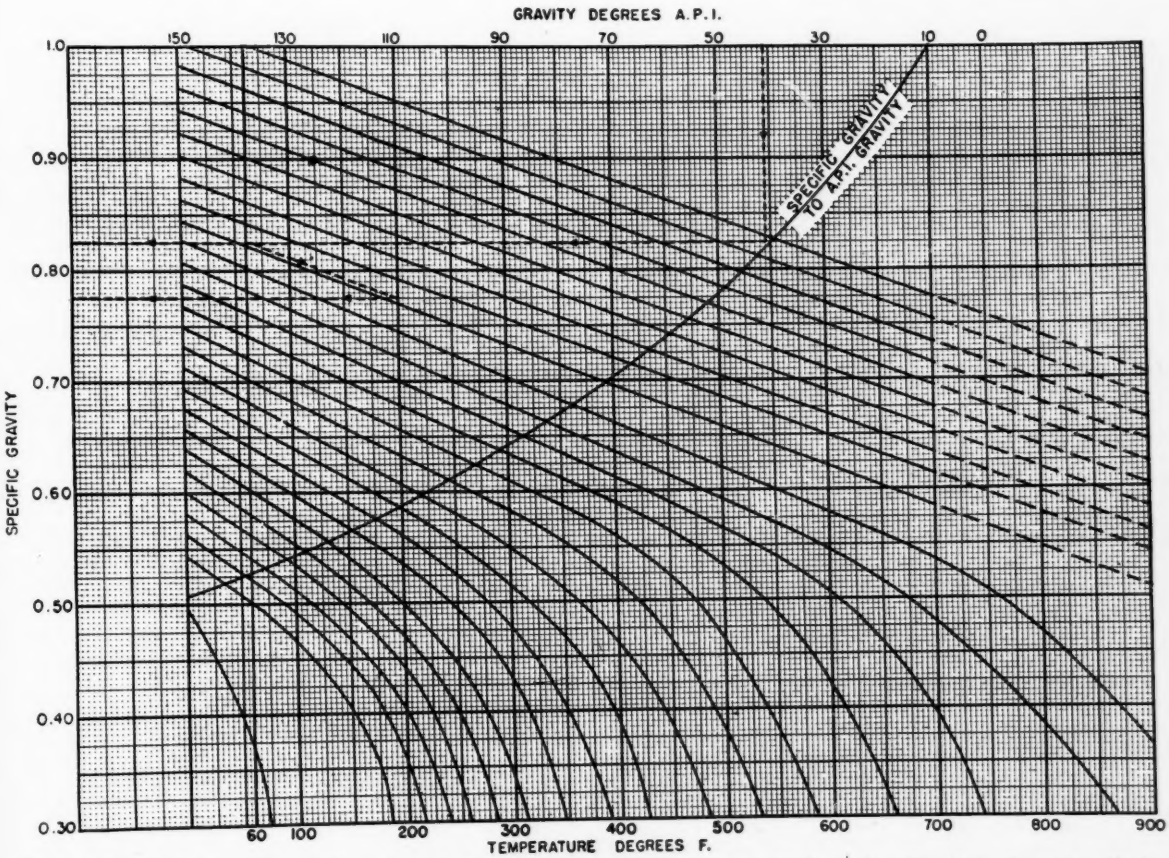


Chart showing relations between specific gravity and oil temperature and specific gravity and API gravity. (Flow Meter Engineering Handbook, by Gess and Irwin; page 47; Brown Instrument Co.)

To convert from degrees API to specific gravity read API value at top of graph, drop to intersection of the specific gravity to API curve. Read the specific gravity at left side of graph. To estimate specific gravity of oil at some required temperature when specific gravity at 60 F is known, select the curve at 60 F, follow its slope to the desired temperature, read approximate specific gravity at left side of graph.

Example: API gravity 40, specific gravity at 60 F—0.825. Specific gravity of same oil at 200 F—0.775.

weight of a unit volume at 60 F divided by the weight of the same volume of water at 60 F.

The term "gravity" has meaning only in translating volume measurement into weight measurement and has little bearing on other properties of fuel oil. No mention of gravity is made in commercial specifications.

Question No. 357

HE WANTS FLEXIBLE SHAFT TO TRANSFER RECIPROCATING MOTION

CAN YOU help us find a manufacturer or supplier of flexible shafts which will transfer a push-and-pull movement?

We are well aware that many manufacturers produce flexible shafts for rotary motions but do not believe these will meet our requirements.

The purpose for which this flexible shaft is intended is in a loom development. On an ordinary dobby loom with leno attachments, it is now desired to add a so-called lappet attachment. The dobby attachment produces the pattern in the weave by controlling the movements of the harnesses, each harness lifting or lowering a separate group of warp threads, by means of a chain carrying pins.

The dobby chain must also control the lappet attachment, which operates an extra group of warp ends by means of needles which can be moved laterally as well as vertically. By this method a small design can be woven into the fabric.

There is insufficient room to operate the lateral movement of the lappet attachment from the same side of the loom as that on which the dobby chain is attached. It was thought that the action could be transferred to the other side more simply by means of a flexible shaft than by means of levers and rods, which have to circumvent the central portion of the loom occupied by warp and harnesses and the devices for their operation.

The mechanical requirements for the flexible shaft are approximately as follows:

Length of stroke:	2 in.
Maximum force:	15 to 20 lb
Speed of operation:	140 cycles (stroke and return)

New York J.E.P.

Question No. 358

HOW MUCH CHLORINE FOR SWIMMING POOL WATER?

LAST FALL I had to take over the operation and maintenance of a swimming pool and, not having had any previous experience with these pools, I must confess I didn't do so well. The moss—or what have you—got ahead of me.

The pool has a water capacity of approximately 6700 cu ft. The water is circulated through 6-ft by 6-ft sand filters by a 77-gpm pump. It is heated by a shell-and-coil type heater. Chlorine is introduced into the water by means of a chlorinator equipped with a glass sight-feed tube 2½ in. inside diameter, which fills to a height of 2½ in.; and the liquid is displaced by a head of about 11½ in. of water.

Please tell me how often the chlorinator must pump to care for the conditions described. Also, should we use blue vitriol in conjunction with the chlorine?

We have all the equipment and apparently nothing to buy, so I will appreciate any help Q & A readers can give me on how to operate it properly. Chandler, Ariz. G.B.

Question No. 359

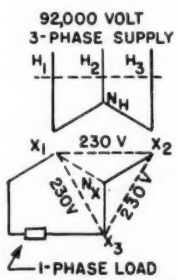
WHAT IS THE FINAL TERMINAL VOLTAGE?

A 3-PHASE transformer, 92,000 to 230 v between terminals is star-star (Y-Y), in both windings. A 1-phase load of 200 amp with a power factor of 90 percent is connected to the 230-v terminals X_1 and X_2.

Assuming a no-load voltage of 230 between X_1 and X_2 what will be the final load voltage between these terminals when the transformer characteristics from line terminals to neutral are:

Resistance high voltage	3340 ohms
Resistance low voltage	.0.031 ohms
Impedance taken from low voltage side for the total winding . .	.0.083 ohms

Brooklyn, New York C.O.D.



1-phase load of 200 amp. 0.90 pf
Diagram of transformer connections by C.O.D.

Question No. 360

CAN HE GET MORE POWER BY BALANCING UP 3-PHASE LIGHTING CIRCUITS?

WE GENERATE current for our power and lighting with an alternating-current generator which produces 220 v, 60 cycles, 3 phase at a rated capacity of 75 kw. The present connections are illustrated in Fig. 1.

It will be noted that the lighting load is furnished by only one phase, and it is our understanding that the corresponding portions of the two remaining phases are therefore unavailable for additional power or lighting and, consequently, wasted. (See Fig. 2A.) It is our further understanding that by distributing the same lighting load equally on all three phases we can obtain a higher level of available 3-phase power without any increase in total generator output. (See Fig. 2B.) Is this understanding correct?

As a result of an increasing rate of production, we find it necessary to obtain a small amount of additional power, either from the local power company or from our own generator by making more power available as outlined above.

In the event that the latter procedure proves feasible, we propose to connect a 5-kva transformer to each of the two phases not presently in use for lighting and to balance the lighting load as best we can, so that each phase contributes an equal share. The power load is, of course, in balance since all motors are 3 phase. We are wondering whether, in order to keep the lighting load balanced at all times, we can connect the secondaries in parallel with a common feeder to the lighting load as shown in Fig. 3. Would this be impractical in view of the fact that the transformers would be out of phase?

If the parallel connection is not advisable, we would have to provide a separate distribution system for each transformer. The problem here is: May we

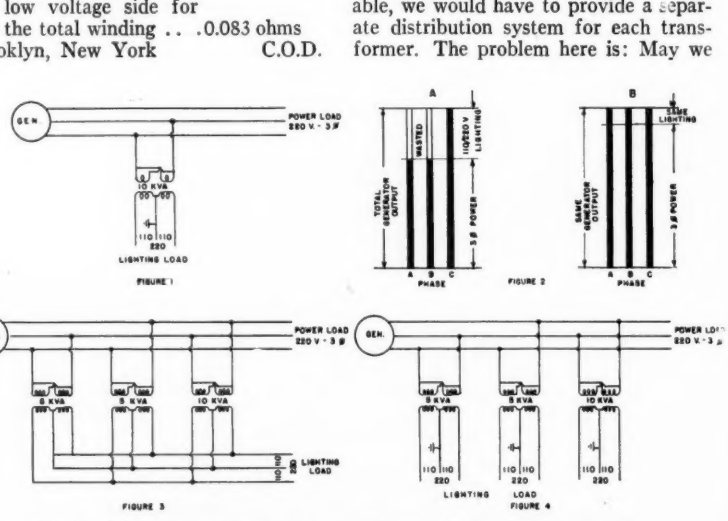


Fig. 1. Generator and transformer connections of E.M.D. as they are now
Fig. 2. E.M.D's. diagram to show that: A—some power is being wasted by present connections and B—reconnection of lighting load would save it, with no increase in generator output. He asks if this is correct
Fig. 3. Should E.M.D. connect his lighting load thus to get the necessary power?
Fig 4. If E.M.D. connects transformers thus, should their neutrals be grounded?

ground one neutral of each transformer as shown in Fig. 4?

It will be noted in each of the above cases that we indicate a lighting load at 110/220 v. We have found this type of service desirable in order to reduce voltage drop in transmission from the generator to the separate distribution panels.

Montgomery, Pa. E.M.D.

Question No. 361

WILL IT PAY TO USE EXHAUST STEAM IN THIS HEATING SYSTEM?

WE HAVE a large plant to heat and have been using live steam for our heating system, supplying it at 100 psi boiler pressure through a reducing valve that reduces the pressure to 5 psi for supply to the heating system.

We also have an air compressor supplying 90 psi air and driven by a 300 hp motor. Also a motor-generator set. These we run in the summer time.

In addition, we have a direct-connected, engine-driven 130-hp generating set and a duplex air compressor driven by 9 by 12 steam engine cylinders.

Now this is what I want to know. Would we or would we not be ahead of the game if we operated the steam engines on generator and compressor and supplied their exhaust to the heating system along with some live steam, instead of using all live steam?

Ohio W.E.C.

Question No. 362

WHAT CAN HE DO ABOUT MOISTURE IN STOKER ASH PITS?

I HAVE a problem about moisture that is getting into the ash pits of our stokers. It corrodes all the metal. The stoker windbox has rusted away half way up. I put in 10 gage black iron on both sides to keep the air where it should be and for the present it is all right.

But I want to think about installing new stokers, for our present ones are very old and maintenance is high on them, but I don't want to do anything about this without first doing something about the moisture.

This moisture comes principally from the ground. We have several HRT boilers, each 66 in. by 18 ft rated at 100 hp each and generating steam at approximately 150 psi, although at present we are only carrying 90 psi. The stokers firing these boilers are set down in pits below the operating floor level so that the bottom of the stoker is about 2 ft below the operating floor. There are some springs, I think, down in the ground underneath the boilers and we have installed a sump between the boilers into which the ground water can drain, with a vertical sump pump to pump it out. This sump pump does help a great deal but it still doesn't get rid of all the water and for various reasons we can't dig the sump deeper or make it any bigger at present. So even though this pump does help a lot, we still get this moisture in the ash pits.

Now if I tried to get some new stokers it would probably be necessary to dig these ash pits even deeper than they are. Of course, there is the possibility of putting some kind of an extension furnace out at the front of the boiler without digging down any more. But if we are still going to have all that moisture to corrode the metal, I don't want to start to think about any new equipment until I can do something about the moisture.

We have tried various things to waterproof the concrete foundations and wall around the stoker pits, but it hasn't worked out very well. When the concrete was originally put in a number of years ago, it was poured right in the water.

If Q & A readers have had trouble of this sort and have overcome it, I would certainly like to have their ideas on what I can do.

St. Paul, Minn. J.A.J.

Answer No. 334

FIRST HE WANTS THE STEAM DRY, THEN HE WANTS IT WET

White Doesn't Get This Wet And Dry Steam Business

SOME OF THE answers to this question would lead one to believe that clothes presses are very "temperamental" machines. Frankly, I do not comprehend this wet and dry steam business. While my experience with presses using steam has been rather limited, still I had some with presses used in a laundry, which was one of the many items I had to look after in connection with a large hospital. Such a matter as wet steam being required in the laundry never happened while I was there. Where different pressures and corresponding temperature were required for the presses, the pressure of steam required to give good results was arrived at by trial and error.

The pressure was reduced by successive stages until it suited the conditions desired. The temperature and pressure of saturated steam have definite relations, and a pressure gage may be used instead of a thermometer, as is very well known. To me it appears to be a question of rate of heat transfer, which is governed by the temperature difference, and utilizing a film of moisture on the heat transfer surface, to slow down the rate, which might just as well be accomplished by reducing the pressure of the steam or the temperature, without introducing a rather unstable agent.

Steam regulating valves can be bought which have a wide range of pressure adjustment, by simply turning a handle to right or left. As I remember it, on two clothes presses, the steam could be reduced from 100 psi to 25 if necessary, by a pressure regulating valve placed conveniently for the operator to change pressure to suit requirements (of course, within certain limits).

The steam used by the laundry I refer to was certainly dry, as it was reduced from 200 psi initial to 100 psi for general use in the laundry. This laundry was a busy place during limited hours of the day, and had to take care of the clothes and all other things required for 2000 patients besides the staff. The last thing that was desired around there was wet steam or the retardation of condensate removal.

Hammond, B.C. WM. S. WHITE

Answer No. 345

WHERE SHOULD RELIEF VALVES BE INSTALLED ON ECONOMIZERS?

Diagram by Cuttitta

IN REPLY to Question No. 345, my diagram is self explanatory, showing valves required at various spots or locations on the economizer. Also I have added a by-pass arrangment for both water and gas.

Passaic, N.J. A. F. CUTTITTA

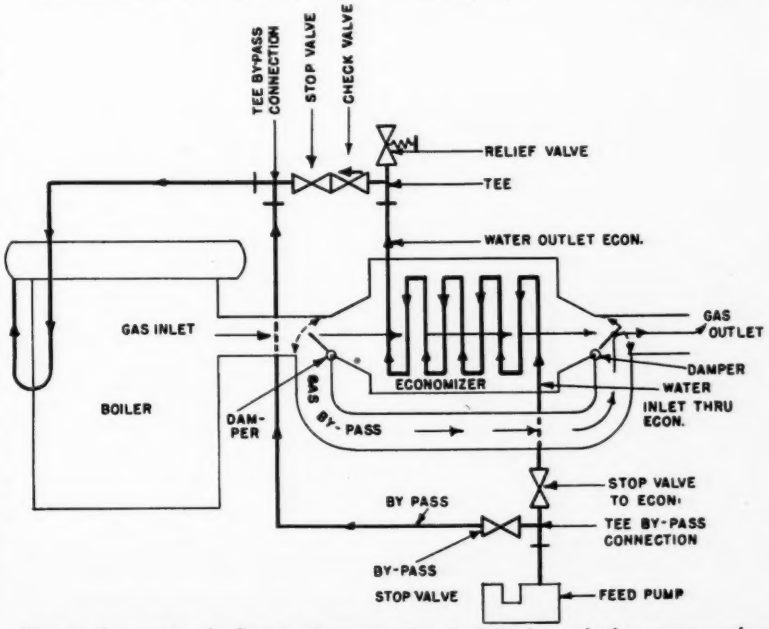
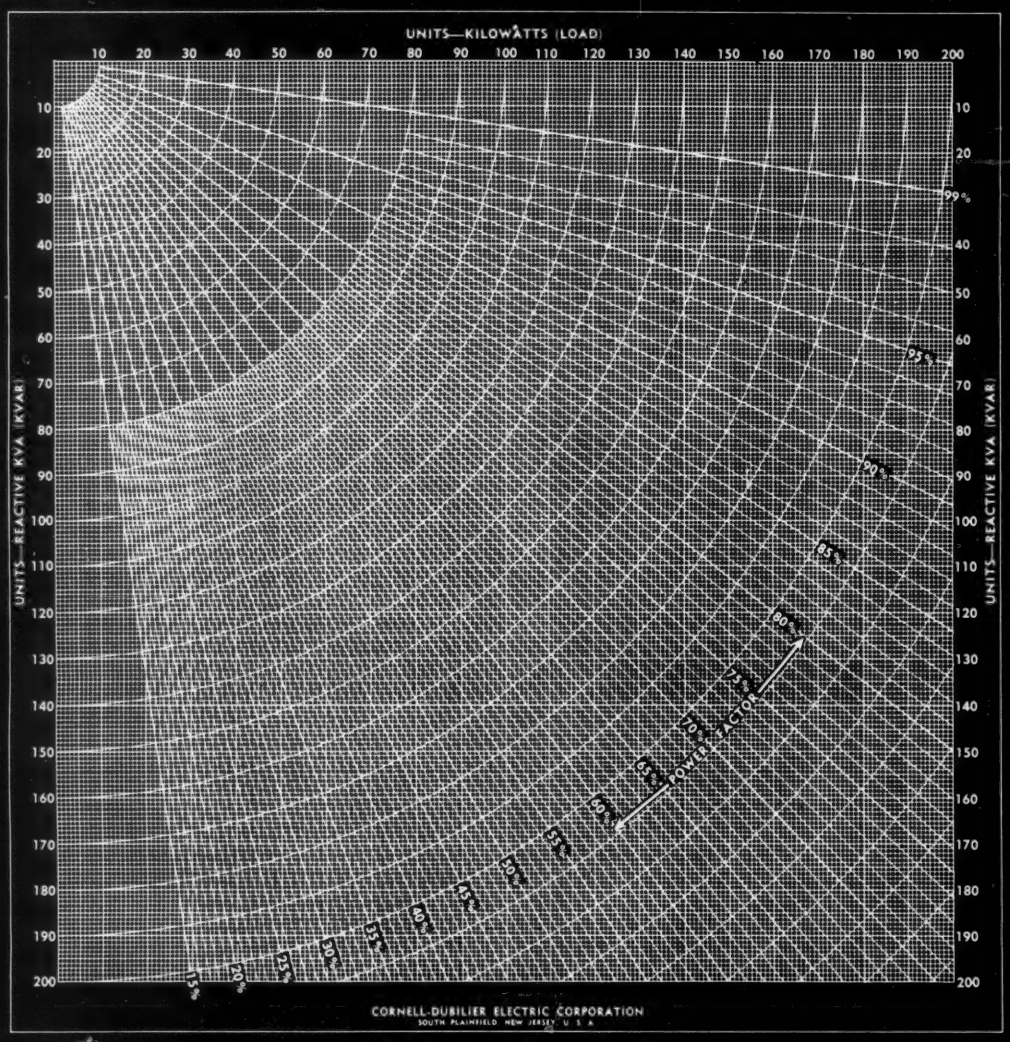


Diagram of economizer by Cuttitta showing location of relief valves and other necessary valves

Vector Chart for Determining Capacitor KVAR Required to Increase Power Factor to any Desired Value



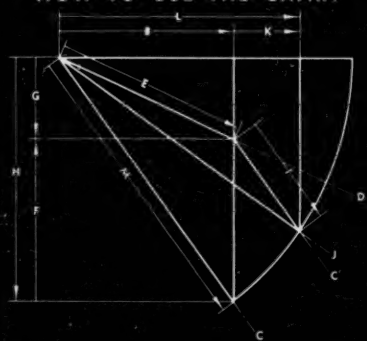
HOW TO USE THE CHART

Find on the chart the point where the radial line representing the *present* power factor intersects the vertical line representing the load in KW. Then find, directly above, the point where the radial line representing the *desired* power factor intersects the same load line.

Next subtract the numerical value of KVAR of the latter (read from the vertical scale at either side of the chart) from the numerical value of the KVAR of the former. The difference between these two values is the KVAR of capacitor required.

To obtain the KVAR of capacitor required for loads higher than those found on the chart, use any convenient multiplier and multiply both the KW load scale and the KVAR scale by the same multiplier.

"Most power factor problems can be solved with the help of this chart. The CORNELL DUBILIER representative in your territory is expert in its use and in the application of capacitors. Call on him for cooperation."



Necessary given conditions:
either KVA (M) and KW (B)
or KVA (M) and power factor (C)
or KW (B) and power factor (C)

From any two of the above factors the desired information may be obtained.

EXAMPLE. Suppose we had an original load of 100 KW (B) and an original power factor of 60% (C).
The original KVA (M) would be 166.
The original KVAR (H) would be 134.
Now if we add a 90 KVAR capacitor (F) to the circuit we get the following:
H − F = G (134 − 90 = 44) = KVAR
The KW (B) will be the same 100
The resultant KVA (E) of 110
The resultant power factor (D) of 91.5%

If the original KVA can be maintained, more KW load can be added to the system as follows:
Add more load (I) of 61 KVA at 60% power factor (C') or 38 KW (K) we shall have a final result of:
Same KVA as originally (M)
The final power factor (J) of 82.5%
The final KW (L) of 138

Courtesy Cornell-Dubilier Electric Corp.

Fire Protection Practices in TVA Hydroelectric Plants

By **H. J. PETERSEN**, Head Mechanical Engineer, Tennessee Valley Authority

RAW WATER is used for fire protection in all plants where the minimum lake level provides sufficient pressure. The Authority has adopted 40 psi at the hose nozzle as the minimum pressure for this service, but a pressure of 60 to 70 psi is preferred and is used when obtainable. In plants where this pressure is not obtained, fire protection is obtained from the treated-water system or from a booster pump.

Fire-hose racks containing 50 ft. of 1½-in. unlined linen hose with cast-brass nozzles are located throughout each powerhouse at strategic points for inside fire protection. Standard 4-in. A.W.W.A. fire hydrants, fitted with two 2½-in. nozzles, are located throughout the plant area and switchyard. A fire-hose cart equipped with a reel and three 50-ft. lengths of 2½-in. double-jacketed, flat-cured, cotton, rubber-lined hose with rocker-lug couplings is provided for switchyard fire protection. This is supplemented by a wheeled cart containing two 100-lb. cylinders of CO_2. National standard fire hose threads are used for the 2½-in. hose and standard iron pipe threads for the 1½-in. hose. Standard underwriters' play pipes are provided for outdoor fires, except that for electrical fires a nozzle is used which atomizes the water spray to the point where it will not conduct electricity.

From a paper entitled Design of Mechanical Auxiliaries for TVA Hydroelectric Plants, presented before Spring Meeting, ASME, Chattanooga, Tenn., April 1946. To be published in full in ASME Transactions.

Fig. 2. Fire protection room at Appalachia Dam, showing CO_2 bottle assembly. Note identification marks on piping at right

Considerations were given to installing built-in fire-protection systems, using either water or CO_2, in the switchyards. These were ruled out because the remote possibility of these fires would not justify the cost of the installation. Sometimes transformers are installed very close to the powerhouse, as on the draft-tube deck. In such cases a fire might cause considerable damage, and built-in water systems, using fog nozzles, are installed. These systems are set off either manually by remote control, automatically by thermostats, or by the tripping of the transformer differential relay which is actuated by a short circuit in the transformer.

In addition to water fire protection, a complete CO_2 system is provided for each plant. This system protects the main generators, the oil-purification room, and the oil-storage rooms. The CO_2 system is designed in accordance with the standards of the National Board of Fire Underwriters for class A systems, which calls for total flooding of enclosed spaces.

A central supply of 50-lb storage cylinders sufficient to provide the gas concentration for one generator called for by the standards mentioned, is connected to all the generators by a complete piping system. This system is energized either manually by remote control or automatically by thermostats located in each generator. A separate system of cylinders and piping is provided for the oil-purification and storage rooms. It is controlled either manually or by thermostats in the room being protected. When this system trips off, all doors and openings automatically close to confine the gas, and pumps, ventilating fans, and other moving equipment shut down.

Portable containers of carbon dioxide in the 4- and 15-lb sizes are located at various points.

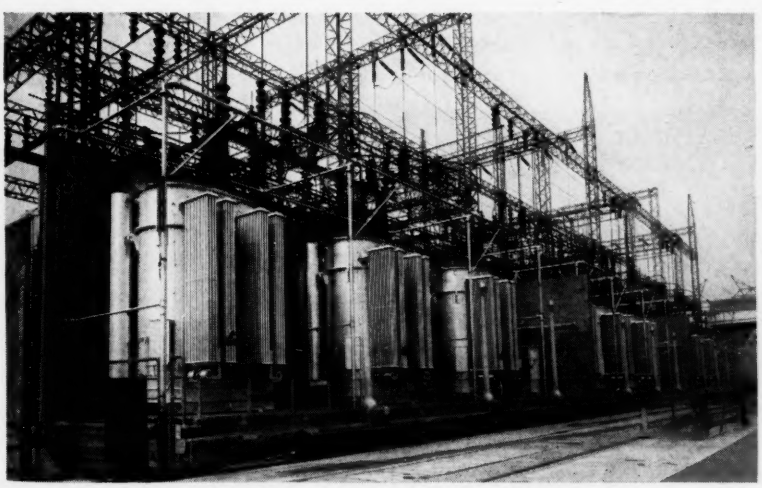


Fig. 1. Water fire protection piping and nozzles—36 nozzles per 3-bank unit—installed on transformers on draft tube deck at Pickwick plant of TVA. Three single-phase, 48,000-kva, air-blast, 13.2/161-kv, 60-cycle transformers per unit

Corrosion of Power Plant Equipment By Water and Steam-III

By **DR. R. C. ULMER**, Technical Director, Industrial Department, E. F. Drew & Co., Inc.

THE PREVIOUS articles on this subject have dealt with corrosion by water in the system leading to the boiler and by boiler water in the boilers. There remains a consideration of corrosion in steam lines leaving the boiler proper, corrosion in the superheater and in lines leading from it, and finally corrosion in handling condensed steam.

Although still concerned with H_2O, the problem with this material in vapor form is quite different from that with it in the liquid form. The temperature of steam is usually higher than that of water and consequently reactions unimportant in the case of water become important. As will be discussed below, the chief of these is direct reaction of the steam with the metal. Another possible difficulty is graphitization which weakens the metal, and of course creep or plastic flow of the metal must be considered in designing equipment.

Steam may cause corrosion of metals by two mechanisms depending on whether the steam is (1) dry or (2) wet.

(1) WET STEAM. Relatively low temperature saturated steam may contain a considerable amount of moisture. The moisture often coats or flows along the walls of the pipe. Where the walls are covered with liquid water, the problem of corrosion is similar to that discussed in the previous articles. That is, if conditions are such that a protective film forms no serious corrosion will occur. If, however, dissolved oxygen or carbon dioxide are present, such a film will not form and corrosion will result.

The usual methods for eliminating the effects of oxygen and carbon dioxide apply but of course they must be carried out in or prior to the boiler. Elimination of the moisture by proper steam release also will greatly aid in eliminating these problems.

The problem of corrosion from wet steam often is aggravated by the fact that the metal may alternately be wet and dry. For example, at times water collecting on the metal may flash into steam or be carried along with the steam. Soluble salts may concentrate or even deposit. These factors tend to interfere with proper protective film formation on the metal surface and corrosion may proceed.

(2) DRY STEAM. Tests have shown that dry steam is not appreciably corrosive to metals used in steam lines and superheaters unless the steam temperature exceeds 800 F. With dry steam corrosion proceeds by direct chemical attack, that is with the so-called bound oxygen of water. This type of corrosion is often referred to as "oxidation." The mechanism is as follows:

$$2H_2O \rightleftarrows 2H_2 + O_2$$
$$3Fe + 2O_2 = Fe_3O_4$$

or combined

$$3Fe + 4H_2O = Fe_3O_4 + 4H_2$$

If the Fe_3O_4 or magnetic iron oxide forms an adherent film over the metal, corrosion usually will not proceed to an objectionable extent with plain steels even at steam temperatures as high as 900 F. This film, for example, because of contraction and expansion caused by temperature variations, may not be impervious and then serious corrosion will result. Serious corrosion of course will result with plain steels in any case if the steam temperature is much above 900 F. In these cases alloy metals must be used, those containing chromium, molybdenum, nickel, etc. being common. In the case of superheaters, the low temperature part of the tube may be of plain steel and the high temperature part of alloy steel.

Excessive steam temperatures leading to corrosion by oxidation are often due to unequal steam distribution in superheaters or other equipment or to excessive heat input to certain areas. Needless to say the final steam temperature will not indicate these conditions. Temperature measurements usually with thermocouples, are commonly used for locating such difficulties.

Regardless of whether the steam is wet or dry, tests of the steam can be made to determine whether this type of corrosion is taking place. As shown in the mechanism for corrosion by direct attack or oxidation, hydrogen is given off. The present of hydrogen in the steam, therefore, may be taken as an indication that corrosion is taking place.

Hydrogen may be detected in some cases by passing the condensed steam through a separating column. The hydrogen will collect. The gas which collects should be tested for hydrogen as it may be nitrogen from dissolved air.

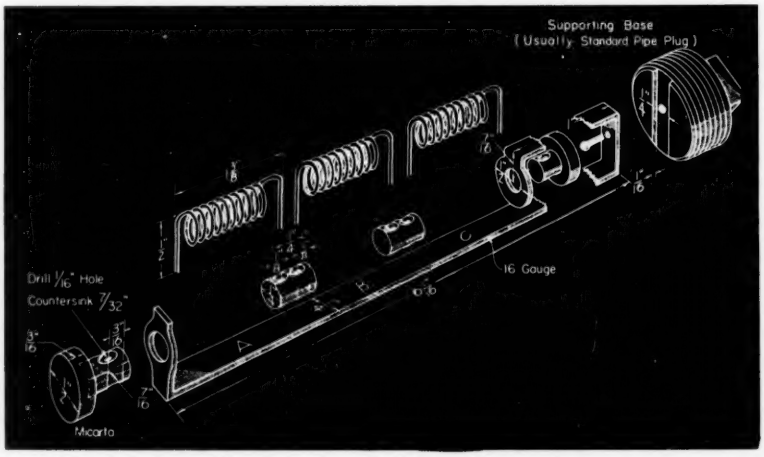
Recorders are now available which give a continuous record of the hydrogen content of the steam. These are of great value in determining when corrosion is taking place and also in checking how effective preventive methods are.

Prevention of Corrosion by "Oxidation"

The proper alloy must of course be used both from a corrosion and strength standpoint. If the steam temperature is over 900 F, certainly corrosion will be serious with plain carbon steels and alloy steels must be used.

The common causes of this type of corrosion, however, are unequal distribution either of steam or heat input, consequently remedying these situations will usually eliminate the problem. As mentioned previously, hydrogen recorders and temperature measuring

Essential parts of corrosion tester developed by National District Heating Association



This is the third and final of a series of articles covering the above subject. The first article dealing with corrosion of boilers was published in the October issue and the second with corrosion of feed lines, feed pumps, heaters and economizers was published in the November issue.

Part III Corrosion of steam lines, superheaters and condensate lines . . . Corrosion tendencies of wet and dry steam . . . Suggestions for prevention of corrosion by oxidation . . . Steam heating piping encounters most commonly corrosion by condensate . . . Pitting or furrowing common indications of corrosion in condensate return piping . . . Dissolved oxygen and carbon dioxide chief causes of corrosion in condensate piping . . . Method of testing for corrosion in condensate lines . . . Methods outlined for prevention of corrosion in condensate lines give consideration to use of alloys, proper design, use of chemicals and deaeration

devices are needed for this work.

Care should be taken also that serious corrosion does not take place when equipment is out of service. This is apt to be the case if the lines are filled with water. If the lines and equipment can be drained and maintained dry this method of "laying up" is to be preferred. If this cannot be done, the lines should be filled with a solution of sodium chromate (400 ppm Na_2CrO_4 + 100 ppm NaOH) care should be taken that the chromate is of equal concentration throughout or concentration cell type corrosion may take place.

Corrosion by Condensate

This type of corrosion is most commonly encountered in steam heating piping although it may be experienced in any system where steam condenses. Although the title corrosion would lead one to believe that failure of metal would be the chief problem, this may not be the case. It often happens that plugging of piping or equipment with corrosion products may be still more troublesome. Regardless of the type of trouble which occurs, its correction usually is difficult and costly since the piping may be inaccessible. Consequently the large amount of effort that has been expended to find a remedy appears to be justified.

TYPE OF FAILURES. Failure of equipment usually occurs either as pitting or as furrowing or channeling. The latter usually shows up first at threads. In serious cases this type of failure may take place in several weeks and failures in several months are quite common.

CAUSES OF THE FAILURES. The chief causes of corrosion of this type are dissolved oxygen and carbon dioxide. If pitting is present it is likely that dissolved oxygen is the controlling factor whereas if furrowing or channeling is present carbon dioxide is the probable cause. Both factors may be operating in a given case so that the failure may occur as a combination of the two types of corrosion.

The effect of dissolved oxygen in causing corrosion has been well known for some time. Until recently little was known regarding the action of carbon dioxide. It is now known that below pH 5.9 a solution containing carbon dioxide will corrode metal in the same manner as a mineral acid having the same pH. With relatively pure water, only about 2.0 ppm of carbon dioxide is necessary to cause this pH. Investigations have also shown that the amount of corrosion that will take place is dependent on the amount of water flowing over or past a point. This means that serious corrosion can result with large amounts of flow even though the pH is not very low.

As to the actual mechanism of the corrosion, it should be pointed out that the steam is not corrosive. The worst corrosion occurs where the steam condenses. At this point the greatest concentration of dissolved oxygen and carbon dioxide will exist. In fact some of these gases may actually be present in the vapor form. Consequently as the low pH condensate reacts with metal more carbon dioxide dissolves thus maintaining the low pH and causing corrosion to continue. The reactions are:

$$CO_2 + H_2O \rightarrow H_2CO_3$$
$$H_2CO_3 \rightleftarrows 2H^+ + CO_3^{--}$$

It is obvious that it is desirable to vent as much of the free gases as possible and in this respect improper design of the system is often an important cause of such failures.

Because of the greatest action at the point where the steam condenses, surfaces of heaters, radiators and traps are the most troublesome with respect to failures.

TESTING FOR CORROSION IN CONDENSATE LINES. Two procedures can be employed to determine whether condensate is corrosive. (1) Chemical tests may be conducted on samples of the condensate and (2) weighed corrosion specimens may be installed in the lines.

The tests commonly conducted on samples of condensate are pH, free carbon dioxide and dissolved oxygen. A pH of over 7.0 is to be desired and dissolved oxygen concentrations below 0.1 ppm are to be preferred. If the pH is 6.0 or lower serious corrosion will usually result in time especially if dissolved oxygen is present. Carbon dioxide will influence the pH which should be used as the deciding test. However, if 2.0 ppm or more is present serious corrosion usually will result.

Various methods may be employed in installing corrosion specimens in condensate lines. The chief problem is to locate them in a place which will give the worst condition. The illustration shows a tester developed by the National District Heating Association for this purpose. The coils can be of the same or different materials. About 30 days is required to get results with this tester for average waters.

Since the corrosion causing failures in condensate lines and similar equipment is due largely to dissolved oxygen and carbon dioxide, these must be considered in preventive methods. The following methods are applicable:

(1) Use of alloys.
(2) Proper design and venting of equipment.
(3) Chemical elimination of carbon dioxide.
(4) Cold water deaeration.
(5) Neutralization of acidity with volatile chemical.

(1) USE OF ALLOYS. Use of corrosion resistant alloys may be justified in a few cases but owing to the cost of their use is not practical in most cases.

(2) PROPER DESIGN AND VENTING OF EQUIPMENT. Insofar as possible, vacuum systems should be designed so as to be leak-free, that is so dissolved oxygen cannot leak in. Vents should be placed at locations so that accumulation of vapors will be avoided. Proper venting alone will reduce the carbon dioxide content of the condensate to a value of 2 to 4 ppm. Finally if possible, the admission of hot condensate, for example from a steam trap, into a cold line or cold water in the system should be avoided. If this is done free carbon may be liberated causing serious corrosion.

(3) CHEMICAL ELIMINATION OF CARBON DIOXIDE. The chief source of carbon dioxide is the breakdown of bicarbonates and carbonates in the boilers. These may originate from the make-up water or may be added to the boiler in the form of soda ash as water treatment. Typical equations are:

$$(1)\quad Ca(HCO_3)_2 \xrightarrow{\text{Heat}} CaCO_3 + H_2O + CO_2$$
$$(2)a-\quad Na_2CO_3 + 2HOH \rightarrow 2NaOH + H_2CO_3$$
$$b-\quad H_2CO_3 \rightleftarrows CO_2 + H_2O$$

With respect to the use of soda ash for boiler water treatment, needless to say this should be discontinued if corrosion is a problem. Alkalinity can be supplied in the form of caustic soda. It is to be regretted that because of its cheapness many water treating companies still use soda ash.

Much can be accomplished in the way of water treatment to decrease the amount of carbonate entering the boiler with the feedwater. The common procedures are:

(a) USE OF LIME. Lime breaks down bicarbonates and precipitates the carbonate as calcium carbonate.

$$Ca(HCO_3)_2 + Ca(OH)_2 \rightarrow 2CaCO_3 + 2H_2O$$

As the lime is used as a pretreatment a large percentage of the carbon dioxide can be prevented from entering the boiler and consequently less will be present in the steam.

(b) ACID TREATMENT. Acid will decompose bicarbonates and carbonates liberating the carbon dioxide. The carbon dioxide can then be removed by aeration or deaeration or a combination of the two. This procedure is often followed after sodium zeolite softening.

(Continued on page 118)

ATOMICS

A New Section added to POWER PLANT ENGINEERING to cover current and forthcoming developments in atomic energy and related developments and applications in Nuclear Physics

Engineering In An Atomic Era

In this address which the author delivered at the fall meeting of the American Society of Mechanical Engineers, he stresses the importance of the engineer's participation in all aspects of atomic energy development and control. He shows that the engineers played quite as important a part in the development of the atomic bomb as did the scientists and that in the future the engineer will be called upon to carry most of the heavy burdens in the development and application of atomic energy to peacetime use

By A. C. KLEIN Engineering Manager, Stone & Webster Engineering Corporation, Boston, Mass.

NO ONE WHO has been present at the detonation of an atomic bomb, and who has witnessed the awe-inspiring devastation that has followed, can have any doubt that we have just turned over a leaf in the book which records the progress of civilization. The new page might properly be captioned "The Atomic Era." Today, except for a few smudges, is is a clean page on which we may write a history of the attainment of peace and plenty or, upon which, God forbid, we shall write the history of the greatest holocaust that mankind has ever known.

Personally, I believe it will be a record of the attainment of peace and of its manifold benefits, but we can not lightly proceed on the assumption that this will be so. Eternal vigilance alone will safeguard us against false steps that may set off a new conflagration. The most certain way we can prevent the use of the atomic bomb for military destructiveness is to hasten the improvement in standards of living throughout the world. To that end, the utmost efforts on the part of engineers and industry must be directed to the development of atomic energy for the generation of low cost electric power so that the peoples of the world may be assured freedom from the causes which have always throughout the history of mankind acted to promote war.

Present Status of Atomic Energy

A. STATUS ON V-J DAY

Between July, 1942 and July, 1945, there was expended in the construction and operation of atomic bomb facilities a total of over two billion dollars. For this expenditure we accomplished the following:

a. Development of the uranium industry beginning with mining the ore and following through to the raw materials necessary for operation of fissionable material plants.

b. Construction of two major fissionable material plants at Oak Ridge, Tennessee, and Hanford, Washington.

c. Construction of atomic bomb assembly plant at Los Alamos, New Mexico.

d. Operation of all these facilities and construction of several atomic bombs at least.

e. The final surrender of Japan and the end of World War II.

Contrary to common belief, scientists were not solely responsible for the development for military uses of atomic energy. Engineers and industry also contributed to a major degree. The true situation was stated very succinctly by Colonel K. D. Nichols shortly after V-J Day. Colonel Nichols said, "The public is prone to hail the inventor and the final product and to overlook the engineering and construction that is essential if the idea of the former is to be translated into the latter. The engineering problems . . . were numerous, unique and staggeringly difficult, the time schedule only slightly short of impossible."

Let us see what the record shows as to the relative magnitude of the work carried on in the fields of engineering and research during this development period. These may be visualized by an analysis of the expenditures made by each group. The figures appear in the statement of expenditures submitted by General Groves in testimony before the McMahon Committee. Three principal processes were enumerated. The amount spent for engineering and construction expressed in millions is 500 for the diffusion process, 317 for the electromagnetic process, and 302 for the metallurgical process, exclusive of housing. The amount expended on research for those three divisions was $5,000,000, $33,000,000 and $42,000,000 respectively. In other words, if we take the percentage of the whole combined engineering, construction and research, about 90 per cent was spent for construction and engineering and 10 per cent only for research. In addition to construction and engineering, the operating organizations are largely staffed by engineers and, to a very limited extent, by scientists. Probably the percentage there was also of the order of 90 to 10.

Let no one say that the engineer will not be called on to bear the heaviest burdens in the years to come.

B. PROGRESS IN PAST YEAR

V-J Day found us feverishly operating all completed facilities to their utmost capacity and completing plant construction. During the past year construction has been completed, plants have been operating 24 hr per day and 7 days per week; efficiencies have been

improved, costs have been reduced and plant capacity has been increased. A recently published statement gave present production as several times that on V-J Day. Much of this has come about through contintued operation, but particularly from lifting the veil of secrecy. This condition has undoubtedly resulted in constantly enlarged stock piles of fissionable material and completed atomic bombs.

C. MANHATTAN DISTRICT PLANS FOR FUTURE

At the present time the entire operation is under the direction of the Corps of Engineers through the specially constituted Manhattan District. Operations may be expected to continue as at present until the creation of a new Atomic Energy Commission.

Additional plans reecntly announced include a research and development program which will include new facilities and extensions to existing facilities under Government sponsorship at five locations throughout the country.

Atomic Energy Commission

During the past year Congress has passed the Atomic Energy Act of 1946 and it is under the provisions of this Act, and under the direction of the Commission that it creates, that the entire atomic energy industry must operate. It is therefore fitting that we examine the make-up of this Commission, its powers and its responsibilities.[1]

Provisions of the Act indicate clearly that Congress intended to create the most capable and powerful Commission in our Government. The Commission will comprise a chairman, four other commissioners, a general manager and four directors, heading the divisions of research, engineering, production and military application. The effort which the Congress made to insure a strong capable Commission is indicated by the fact that the salary paid the chairman exceeds that of the members of the President's Cabinet. The salaries of the commissioners and the general manager are set at $15,000 per year, which is the same as the Cabinet members' salaries, and the salaries of the directors, $14,000, exceed by a substantial margin the salaries paid members and heads of most other independent commissions. It is to be hoped that the President will recognize the challenge and will appoint the best Commission possible. To guard against the appointment of any misfits, the Bill provides that the initial appointees shall hold office for a period of two years only, and that entirely new appointments shall be made at that time for the normal five-year tenure of office.

The Act also provides for two advisory committees, namely, Military Liaison Committee appointed by the Secretaries of War and Navy, and General Advisory Committee consisting of nine members appointed by the President from civilian life. The function of the latter Committee is to advise the Commission on scientific and technical matters. It is the evident intent of the Act that the advice of the General Advisory Committee would be sought mainly on nonmilitary matters.

The Atomic Energy Commission will inherit entire atomic empire, including plants, finished and semifinished bombs, and all other property now held by any Government department or agency which pertains to nuclear or atomic processes. It will have sole power over the entire industry, starting with uranium ore in the ground, up to and including finished products containing and produced from uranium. It will also take over all patents and contracts and secret information and, subject to the direction of the President, it will have sole power for desseminating information and distributing uranium products, including bombs.

If, for instance, one of our industrial concerns or one or a group of our electric utilities wish to develop processes involving atomic energy utilization, permission must first be obtained from the Commission to do so. The Commission may then allot sufficient stocks of uranium or fissionable material to the project either free or on terms it fixes. It may also bear part of the cost by making grants in aid, or it may even finance the entire development.

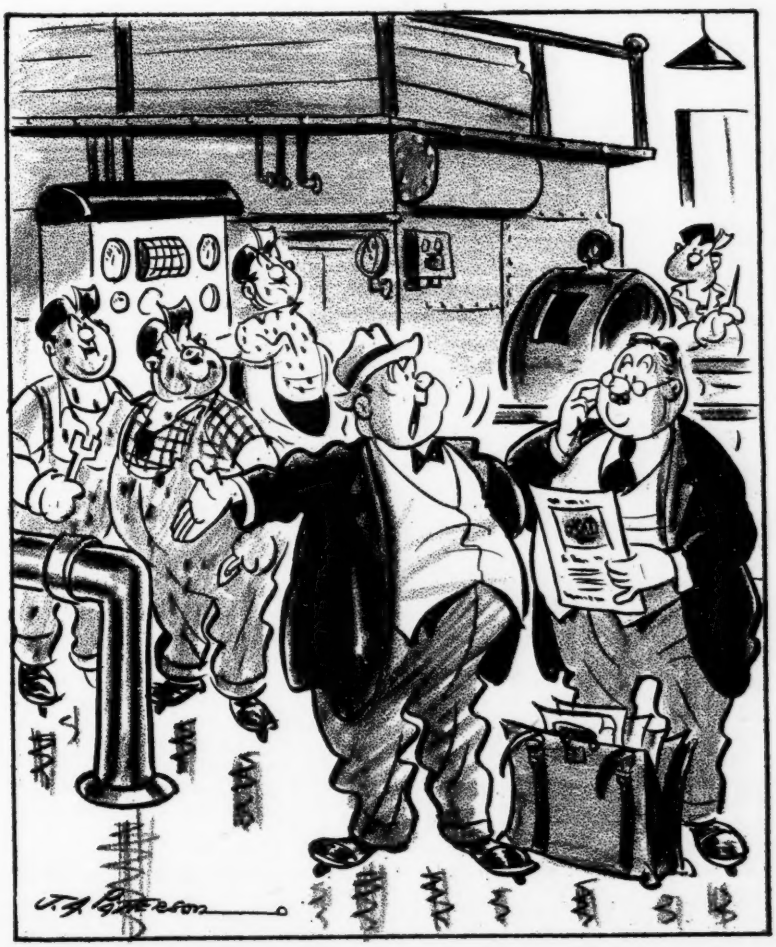
Future of Atomic Energy

A. MILITARY ASPECTS

No discussion of atomic energy can overlook the military aspects. We as engineers are vitally interested in seeing that the international situation is cleared up at the earliest possible moment. To the extent that our plants must operate for military purposes, just to that extent are they hindered from producing material for peacetime purposes.

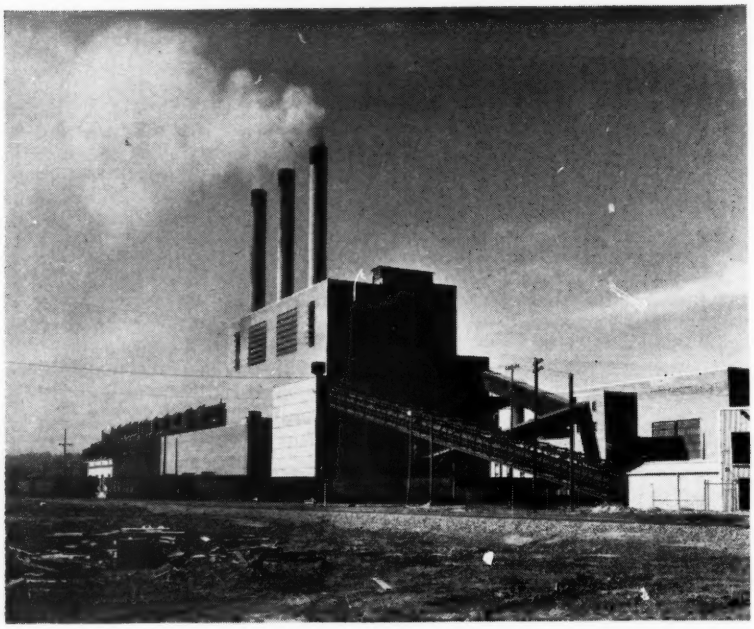
No one who has gone through the engineering and development work which led to production of bombs can do other than to conclude that it will be a decade before any other nation can vie with us in atomic bomb production. I venture to predict that our research program, if implemented with proper engineering development, will keep us in the forefront for a generation at least. During that time it behooves us to settle the international situation so that it will never again arise to threaten us.

We have the bombs. We have the production facilities. We have the engineering know-how. We have the industrial plant to implement that know-how. It would be the height of folly



Why think of it—with our atomic powered engines you can do away with all these useless men

[1] Since Mr. Klein wrote this, President Truman has appointed the members of the Atomic Energy Commission. They are as follows: The Chairman, David E. Lilienthal; the members, Robert E. Bacher, Lewis L. Strauss, William W. Waymack, and Sumner T. Pike.



This huge steam plant and power plant at Oak Ridge, Tenn. represents only a small portion of the engineering talent that went into the development of the atomic bomb

for us to throw away the advantages which this position gives us, except on our own terms. Nearly a year ago, in a paper delivered before the Boston Section at the Harvard Lecture Hall, I outlined a program whereby we might permit the Security Council of the United Nations to direct us to use our bombs for punitive measure. At that time none of us could visualize the studied noncooperation of the Soviet Union. It seems to me that the time has now come when we must go forward with a plan for the control of the atomic bomb based on associating ourselves with those nations which are favorably disposed to our plan. Let other nations stay on the outside if they do not care to come in. When and as they do care to come in, we can entertain their application.

It may be claimed, in opposition to such a plan, that we may be subjected to another Pearl Harbor at the hands of some unfriendly nation not a member of the atomic energy group. I see little danger of such a contingency as long as we have a large stock pile of bombs. Let us suppose some nation was fanatic enough to make a sneak attack on some of our coastal or industrial cities. Suppose they badly damaged New York, Pittsburgh, Philadelphia and Boston, and paralyzed our industrial production at those points. Fearful as such a contingency would be to contemplate, it would not protect the aggressor nation against rapid and highly destructive retaliation. We would not be foolish enough to have bombs located at vulnerable points. Rather, they would be hidden in the Berkshires, the Catskills, the mountains of the Pacific Coast, and in carefully selected hideouts in our rural areas. From these points skilled operators could dispatch them with unerring aim and completely paralyze industry of the aggressor nation. I do not look for such an eventuality, but I do contend that the fear of retaliation would prevent any nation from attacking another one which had an adequate stock pile of atomic missiles, in just the same way that fear of retaliation banned the use of poison gas and disease germs during the late war.

B. Peacetime Application

The peacetime application in which you are all primarily interested is that of atomic power. How soon will it come? How extensive will its application be, and what will be its effect on our power bills?

In my opinion, the task of producing atomic energy and of converting it into electricity or steam is a task equal in magnitude to that of constructing one of the major atomic bomb material plants, and the time that will be required to do so will be of the order of from three to five years. Moreover, after the project is solved from an engineering standpoint, it will not necessarily be economically sound. Only continued operation of atomic energy plants for a period of many years, and the improvement in design and operating techniques that will come through such operation, can result in what we commonly term "cheap" atomic power energy. I would say that it would be at least ten years before atomic energy will have any effect upon electricity costs.

Now, what will be the effect of the economic development of atomic piles upon our industries? The first question is to what extent will it supplant coal and other fuels. The answer is, it will supplant them to a limited extent only and that there is room enough in the growth of our demand for power to absorb all of the uranium that will be produced and at the same time to keep our coal mines, our oil wells and our hydroelectric plants operating at normal capacity. The effect of atomic energy will be minor compared to the fluctuations in fuel demand that accompany changes in our business cycles.

Next, what industries can generate atomic energy to best advantage? The answer is that only the very largest consumers of power will be able to consider operating their own atomic energy plants. The atomic energy unit is inherently a large scale device. It is accompanied by continuous emission of radioactivity. Operators and property must be protected by walls of concrete, usually about six feet thick. Chemical separation facilities must be provided so that the active material may be reprocessed periodically to remove the fission products which after a time slow down or stop the operation. All of these are factors which will preclude the development of atomic energy on any small scale. I would anticipate that the first commercial plants to be built would be of the order of hundreds of thousands, perhaps even up to a million kilowatts in size, that they would be connected to an interconnected network of several of our largest public utility systems, and that industry and the public in general would be affected very little by their operation except as an ultimately lower cost of producing electricity will make it possible to lower electric power bills. At a later time, the electrochemical industries will undoubtedly have their own atomic power plants, but in the main, our industries will continue for a long time to receive their atomic power over the lines of their electric power utilities.

Another important peacetime use of atomic energy is in the production of radioactive materials for medical and biological purposes. This work is now under way on a semi-commercial basis. No outstanding difficulties or problems remain to be solved. In fact, the Manhattan District has announced the production and distribution of several radioactive elements and there is no reason why production should not continue on an increasing scale as the need for specific materials becomes indicated.

Another important outgrowth of the atomic bomb work is in the field that has been opened up for the separation of isotopes. Isotopes are forms of an element which differ principally in their weight. They do, however, differ very slightly in other respects and it is quite probable that their separation and study may lead to important developments in chemistry and metallurgy. Isotope study is a practically untouched field and much work lies ahead for scientists and engineers in it.

Time does not permit the enumeration of the many collateral advances in engineering which have resulted from atomic bomb work. Suffice to say that they have had and will have a profound effect on the future of engineering and industry.

With this vista of the atomic era

before us, it becomes highly important that we consider the responsibilities that face engineers and the steps that should be taken to discharge them. Two facts are evident:

a. The engineering profession will be called upon to play a major part in the development of the atomic era.

b. We must work with the Atomic Energy Commission and under rules laid down by it.

Such being the case, we have a vital interest in the makeup of the Commission and in collaborating in the formation of its rules of procedure. We as an organization, representing the mechanical engineering profession, should make our recommendations known to the President and later to the Commission, and we should direct those communications toward the appointment of capable, experienced commissioners and directors.

A short time ago, I addressed a letter to the President in which I recommended that he appoint as one of the Commissioners, and preferably as Chairman of the Commission, an experienced engineer who had an administrative background. The assistance and support of the Engineers Joint Council has been enlisted for that recommendation. The National Society of Professional Engineers has endorsed this recommendation, and I have just been informed that the Engineers Joint Council did likewise at its meeting of September 26.

Conclusion

The big question before us is how the engineers comprising the Engineering Societies can take their part in shouldering the responsibilities of the atomic era. I have tried to point out that engineers must accept these responsibilities. The only question therefore is how this Society will do its part to facilitate their work.

I should like to make a few recommendations along these lines. The first is that the Society should organize as one of its professional divisions, a Division of Atomistics. Such a division would prove the rallying post for the thousands of our members who contributed to the atomic bomb development, and who still maintain a keen interest in atomic engineering. If we fail to organize such a division, it will inevitably result in the formation of an atomic engineering society. We have too many engineering societies now—many of them have been formed because of the lethargy of the Founder Societies in recognizing the growing importance of component elements of engineering. Let us not make the same mistake again, but let us actively lay plans so that the formation of such a professional division can be officially approved at our annual meeting in December.

Pending the formation of such a division, much constructive work can be done and should be done. We should study the Atomic Enery Act of 1946 and take advantage of the opportunities it offers for constructive service in the formation of the Atomic Energy Commission. Undoubtedly, an engineer will head the Commission's Division of Engineering, but there is no reason why all of the divisions, except Military Application, could not to advantage also be headed by engineers. Another opportunity we should not overlook is in connection with the President's appointment of the General Advisory Committee. This is to be composed of nine members appointed by the President from civil life. At least five of these should be engineers, one appointed from each of the five Societies which compose the Engineers Joint Council. This would be a cross section of the entire engineering profession and would insure the most efficient cooperation between the Societies and the Atomic Energy Commission.

This is no job for individuals. It is a job to be undertaken by the ASME and its fellow engineering societies. It is a job to be well and carefully planned and then to be prosecuted with all the organized might of the engineering profession. If we obtain a competent, well balanced Commission, our future work of implementing the problems of the atomic era can be handled with efficiency and dispatch. Let us resolve to do exactly that, so that the atomic era may be one, not of the fratricidal destruction that is so generally predicted, but of the extension of peace, plenty and high living standards to all the peoples of the world.

SYNCHROTRON YIELDS 70,000,000-V X-RAYS

A BEAM OF 70,000,000-v x-rays has been produced in the General Electric Research Laboratory from a new and compact type of atom-smasher, the synchrotron.

This was announced at Philadelphia by Dr. Herbert C. Pollock, General Electric Research Laboratory scientist and leader of the group working on it, in a lecture before the Franklin Institute describing various types of atom-smashers in the G-E laboratory.

The success of this device, the first to operate in the Americas, built as part of a project sponsored by the Office of Naval Research, indicates the possibility of producing radiations of much higher energies, for atomic study, with greater economy than with earlier equipment, according to Dr. Pollock.

The synchrotron as originally proposed was invented independently by V. I. Veksler, in Russia, and E. M. McMillan of the University of California where a 300,000,000-v synchrotron is under construction. The new atom-smasher in its present form combines certain features of the cyclotron with those of the betatron, another type recently developed. While the cyclotron is used for accelerating protons, positively charged atomic particles, the synchrotron and betatron both are used for accelerating electrons, which have negative charges.

The betatron has been developed principally at the University of Illinois and at the G-E laboratory, where one emitting 100,000,000-v x-rays is now operating. This is a machine weighing 135 tons, and consisting principally of a huge electromagnet. Between the magnet's poles is a glass "doughnut," of 74 in. diameter. Each time the alternating current supplying the machine goes through the first quarter of its cycle, electrons are fed into the doughnut from a heated filament; then they are accelerated on successive trips around as the magnetic field builds up. At the peak their orbits are shifted, they hit a target and a beam of potent x-rays is generated.

Though the 70,000,000-v. radiation from the new synchrotron has more than two-thirds the energy of that from the betatron, the machine is smaller, weighing only about 8 tons. Thus, said Dr. Pollock, it offers fascinating possibilities for going to much higher voltages with less weight of iron. The 200,000,000-v cyclotron recently placed in operation at the University of California, he reminded his audience, weighs about 4000 tons.

The new machine combines both betatron and synchrotron operation, and was invented jointly by Dr. Pollock and his associate, W. F. Westendorp. At the beginning of each cycle of operation, which is repeated 60 times a second, the acceleration of electrons starts off as in a betatron and is continued as in a synchrotron. The electrons are injected from a hot filament and are speeded as the magnetic field builds up. When they have acquired energies of about 2,000,000 v, they are moving at 97 per cent of the speed of light—186,000 miles per second. They cannot go faster than light, so further increase in energy is manifested as an increase in mass.

Part of the doughnut, which has an outside diameter of 27 in., is made of metal, double-walled and with a gap on the inside. This is connected with an electrical oscillator, essentially a radio transmitter operating on a frequency of 163 megacycles, or a wavelength of a little less than two meters. After the electrons have reached 2,000,000-v energies, and are moving practically at constant speed, nearly that of light, the oscillator is automatically turned on. In the oscillating electric field, the electrons quickly get into step and come around in groups, receiving an increase in energy each time they go past.

Dr. Pollock explained that this takes care of another limitation to the betatron. When electrons are moving at energies of many hundreds of millions of volts, they actually radiate away much of their energy, just as do the electrons moving back and forth in a radio antenna system. With the synchrotron, however, there is automatic compensation. If an electron loses energy, its orbit contracts, and the next time it returns to the gap a little sooner. This causes it to get more than its normal quota of energy.

After the electrons have reached their full velocity, said the speaker, the oscillator is turned off. All the electron orbits contract. As a result the electrons hit a tungsten target, generating x-rays.

Soda Black Liquor Generates Steam at New S. D. Warren Co. Plant

By **R. E. GILMAN,** Engineering Department, S. D. Warren Company

First high-pressure recovery unit in this country to burn black liquor from soda pulp process installed at new power plant of S. D. Warren Co., paper manufacturers, at Cumberland Mills, Maine . . . It is part of initial installation in new steam and by-product power plant . . . This unit recovers valuable chemicals for pulp mill processes and generates 95,000 lb per hr of 560-psi, 725-F steam as a by-product . . . Initial development includes new 3000-kw non-condensing turbine generator unit . . . Four steam systems at 560, 150, 36 and 10 psi now co-ordinated . . . Existing 150-psi boilers and 4250 kw of condensing turbine capacity retained and tied into system . . . Future steps in plant development to include a 4000-kw back-pressure turbine generator, two 560-psi coal-fired steam generating units and later a 3000-kw back-pressure unit . . . Complete details of black-liquor preparation and burning, steam generation in recovery unit . . . Air-puff soot blowers and design details for cleaning unit . . . Steam air heater for heating combustion air supplied to black liquor furnace . . . List of principal equipment

IN 1941 the S. D. Warren Co. completed plans for a new steam generating and by-product power plant. The initial phase of this development was accomplished during the war and went into operation in July, 1945. It consists of high-pressure chemical and heat recovery steam generating unit, back-pressure turbine generator, necessary auxiliary equipment and buildings, as described in this article. This steam generating unit, shown in Fig. 2, is the first high-pressure unit in this country firing black liquor from the soda pulp process. Details of this unit and its auxiliaries and of the entire first phase of the power development are given in this article. A complete list of the equipment appears on page 118.

The remainder of the program will be completed during the coming year and will consist of two high-pressure, pulverized-coal-fired topping boilers and turbine-generator equipment. When this part of the program is completed, the general steam and water flow arrangements of the plant will appear as in Fig. 1.

Prior to this new development, steam was generated entirely at 150 psi saturated by 16 coal fired boilers, half of which are fired by pulverized coal and the remainder by stokers. Steam from this low-pressure plant served two condensing turbine generators, as well as process demands for the soda pulp and paper mills. These demands required steam at 150, 36 and 10 psig.

The new installation described here, with the exception of high pressure piping, was laid out by our own Engineering Department under the super-

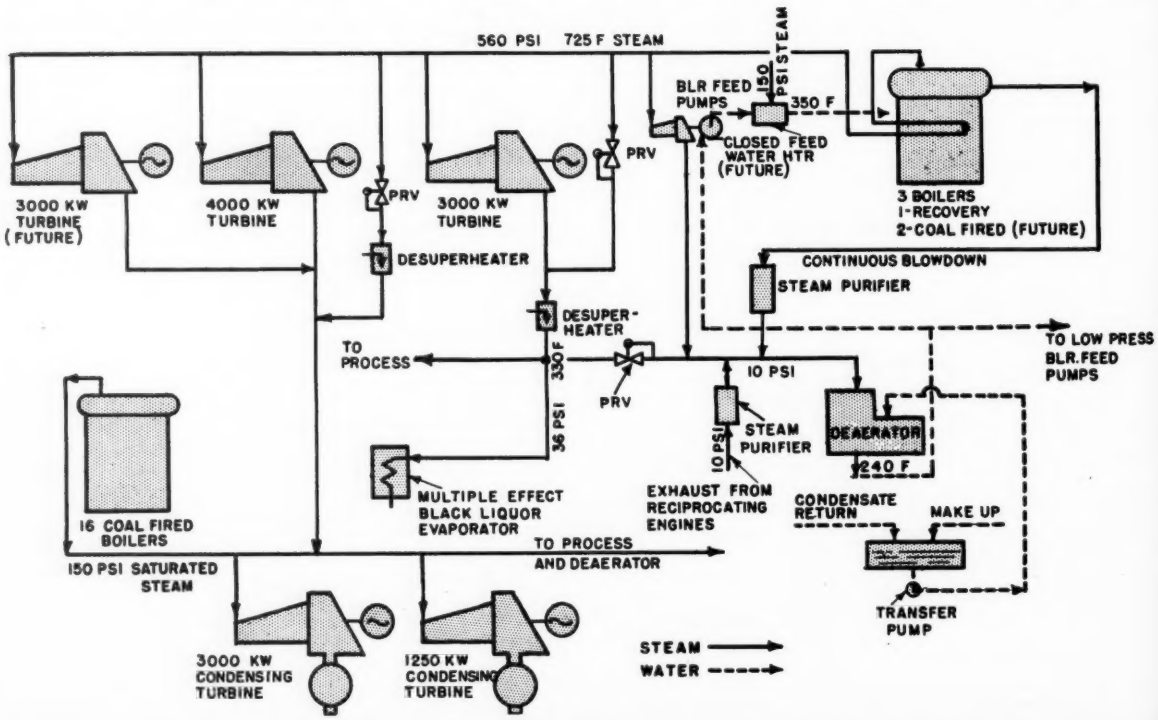


Fig. 1. General diagram showing steam and water connections of new 560-psi recovery steam generating unit, new 3000-kw back pressure turbine, existing 150-psi boilers and condensing turbines, evaporators and other equipment in new S. D. Warren power plant and illustrating how four steam systems at 560, 150, 36 and 10 psi are interconnected for economy and reliability

vision of K. E. Terry, chief engineer.

Before discussion of the operation of the recovery boiler, Fig. 2, it may be of interest to trace briefly the origin of its fuel. The soda process for manufacture of wood pulp depends on the fact that alkali at high temperature will dissolve all other constituents of wood except the cellulose, leaving the cellulose or pulp in a form suitable for paper making. This process is accomplished in digesters, which are charged with wood chips and sodium hydroxide solution and allowed to cook for a few hours under 115 psi steam pressure. When the cook is completed, the contents are blown into a blow tank and thence to the washing tanks.

The contents are dark brown or black in color and are washed first with hot weak liquor from the recovery system and finally with hot water. The resultant pulp then goes to the bleach plant and on to the paper mill.

The remaining liquid, termed black liquor, contains intercellular matter, alkali and about 90 per cent water, i.e., a solution of organic matter and sodium carbonate. Due to the high percentage of water content, the liquor must be further evaporated before it can be used in a self-sustaining combustion process. The liquor, therefore, is further evaporated to 50 per cent solids by multiple-effect evaporators using 36-psi steam supply. The black liquor is then pumped to the recovery plant.

Details of Recovery Unit

The primary purpose of the new chemical recovery unit is to burn the organic matter and recover the inorganic matter which is almost entirely sodium carbonate. This is later chemically combined with calcium hydroxide to form the sodium hydroxide used in the digesters. In this process, valuable by-product steam is generated.

The new chemical recovery unit consists essentially of a 4-drum boiler and cascade evaporator. The liquor, which contains only 6300 Btu per lb on a dry basis, is pumped to the cascade evaporator where it is further evaporated to 81 per cent solids. Heat for evaporation is supplied by the exit gas from the boiler.

It is desirable to hold the solid content of the liquor constant leaving the evaporator, so that the liquor entering the furnace will have a constant Btu value. This is maintained by controlling the boiler exit gas temperature by changing the position of a by-pass damper, which, when open, by-passes the last two boiler passes. With the damper wide open, maximum evaporation is obtained with a temperature entering the evaporator about 775 F. With the damper closed, gases pass through last two passes and exit gas temperature is around 500 F. Exit gas temperature from the cascade evaporator is about 300 to 350 F.

Circulation in the evaporator is maintained by four revolving wheels with blades, which also serve to collect entrained solids in the flue gas. Chemically these solids are sodium carbonate and are therefore valuable to recover. They are continually released from the blades as the wheels revolve through the black liquor in the evaporator. Constant black liquor solids or viscosity in the evaporator is indicated by a watt-meter giving the power on the motor drive for the evaporator wheels.

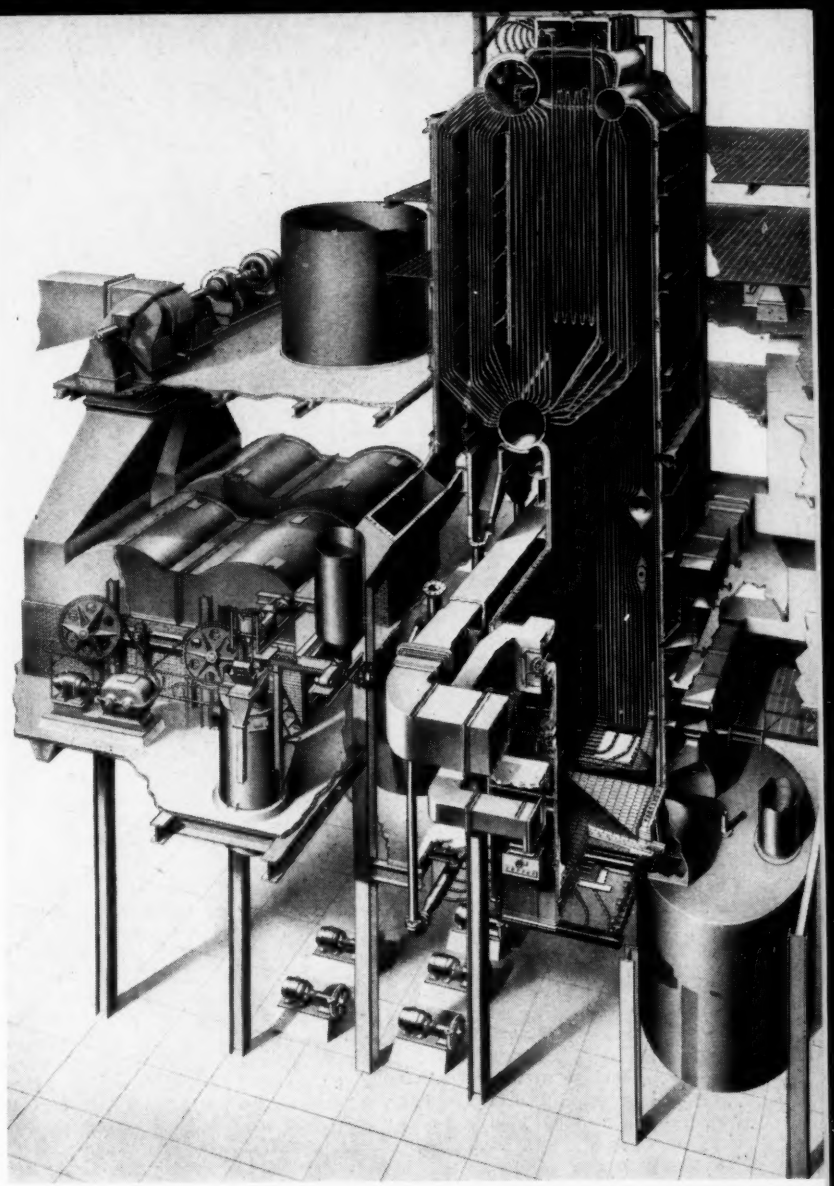


Fig. 2. Cross-section perspective view of Warren's new recovery steam generating unit. It is capable of delivering 95,000 lb per hr of steam at 560 psi, 725 F as a by-product of the recovery of chemicals from the burning of black liquor from the soda pulp process. Furnace completely water cooled. Smelt from furnace flows into tank at lower right. At left center is the cascade evaporator. Combustion air ducts around furnace walls

Hoppers under the second and third boiler passes collect solids in flue gas and these are dissolved in water continually. When the percentage of solids is high enough, this solution is pumped to the cascade evaporator.

Handling and Burning the Black Liquor

The black liquor leaves the evaporator at about 230 F to be pumped to the liquor nozzles into the furnace. Because of the high solid content of the liquor at this point, care must be taken that the liquor temperature never is allowed to cool enough to freeze. Piping from here to the furnace is therefore provided with several steam blowout lines, used when shutting down, to clear lines of black liquor. These blowout lines together with the black liquor pumps that deliver the black liquor from evaporator to burners, are shown in Fig. 7.

The black liquor is further heated before entering the furnace by a primary and a secondary direct-contact steam heater, using 150 psi steam to heat the liquor to about 250 F to give proper viscosity and burning conditions. It is then sprayed through oscillating liquor nozzles, Fig. 6, into a completely water-walled furnace, Fig. 2.

Because of the low heat value of the liquor, combustion does not take place

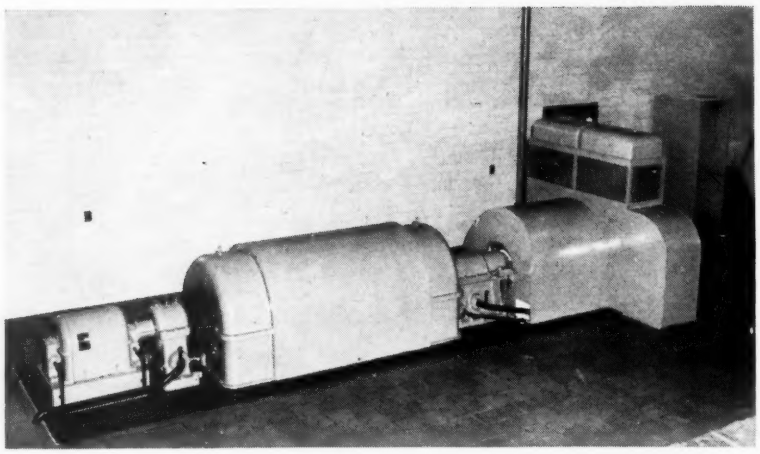


Fig. 3. View of new 3000-kw turbine-generator in Warren power plant. Takes steam at 560 psi, 725 F, exhausts at 36 psi 330 F. Similar 4000-kw unit to exhaust at 150 psi will be installed soon

immediately. The liquor falls about 20 ft to a continuously-burning liquor fuel bed covering the entire floor of the furnace. The height of this bed is controlled by the amount of air admitted to the fuel bed through air ports between the furnace tubes at that elevation. Heat from this fuel bed burns part of the liquor in suspension, while the remainder is burned on the bed itself.

Hot liquid smelt continuously runs from the bed on a sloping chrome furnace floor through two water-cooled smelt spouts into a dissolving tank. The smelt or sodium carbonate is dissolved in water and pumped out continuously at 21 deg Bé and 195 F for process use. The solution is agitated by bubbling air, supplied from a small air compressor. Suitable vent is provided to the roof so that no pressure will build up in the tank due to hot smelt contacting the solution and generating steam.

Steam Generation by Recovery Unit

Boiler and superheater tubes have wide tube spacing to prevent bridging over by entrained solids in the flue gas. The top half of the furnace is provided with about 400 small lance ports, so that all parts of boiler and super-heater tubes in the furnace are accessible for hand lancing. Top of super-heater and rear passes of boiler tubes are kept clean by 26 soot blower elements, which are blown once a day, with the exception of elements where gases pass perpendicular to tubes. The latter elements are used three times daily.

Soot blowers, Fig. 4, are automatic air-puff type using 250 psi air pressure. Hand lancing is done with 100-psi air pressure. After one year of operation on this schedule and with constant check on boiler draft losses, boiler passes have been maintained clean.

The steam generating capacity of the recovery boiler is 95,000 lb per hr (at 560 psi and 725 F leaving the superheater) when firing black liquor. Steam production at present is maintained at about 75,000 lb per hr to supply turbine, multiple-effect evaporators and some process demands. If the black liquor supply decreases, steam production is maintained by the addition of fuel oil to pick up the required load. Four mechanical atomizing oil burners are located about three feet above the furnace floor and serve primarily to heat the furnace floor before starting to fire black liquor. Each has a capacity of 60 gph. Two large steam-atomizing oil burners are located on each side of the furnace 25 ft above the furnace floor and are so located as to give designed conditions of steam temperature. These are capable of carrying the full steam load of the boiler.

Recording instruments for the unit give records of steam flow—air-flow, black liquor flow, CO_2, steam temperature, boiler outlet draft, gas temperatures entering and leaving evaporator, black liquor temperature to furnace. Recording ammeters are installed on evaporator driving motors. Indicators show the usual steam and feedwater pressure, remote water level as well as bi-color water level and black-liquor pressure. Draft indicators are located through unit. Fig. 8 shows the boiler control and instrument panel, located on the operating floor at burner level.

Draft and Feedwater

Air supply is manually controlled by a motor-operated damper at the outlet of the forced-draft fan. Air is preheated to 300 F by the steam air heater, Fig. 5, using 150-psi steam. Constant furnace draft of 0.15 in. H_2O is automatically controlled by a variable-speed induced-draft fan with hydraulic coupling. Boiler feedwater level is automatically controlled by a two-element control.

Feedwater at present is heated to 240 F in a deaerating heater, Fig. 1. During the next few months a closed heater will be installed to raise the temperature to 340 F.

Phosphate is pumped direct to boiler. Caustic and santosite at present are fed into the suction of the boiler feed pumps, Fig. 9. When the two new high-pressure boilers are in service, these chemicals will go directly to the deaer-

Fig. 4. View along side of new Warren recovery boiler, showing automatic air-puff soot blowers and some of lancing ports through which hand lancing is done with 100 psi air. After a year of operation on this schedule, boiler passes have been maintained clean

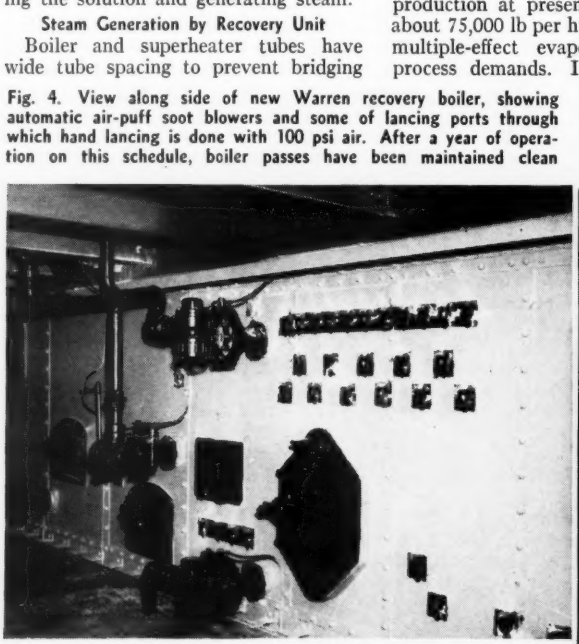
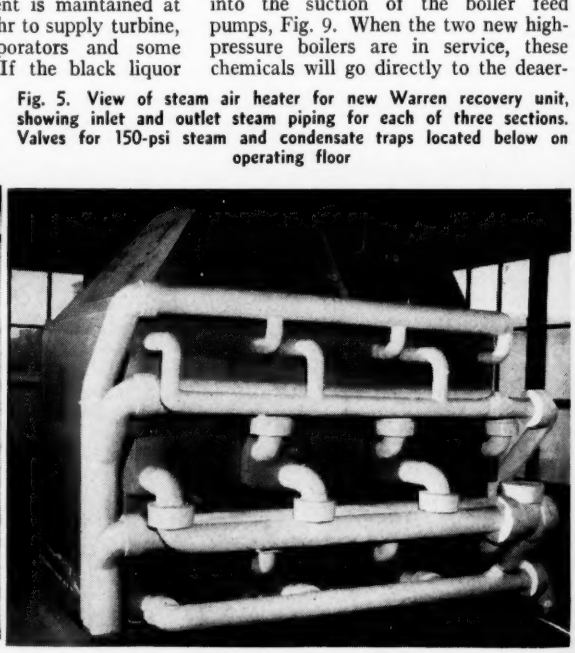


Fig. 5. View of steam air heater for new Warren recovery unit, showing inlet and outlet steam piping for each of three sections. Valves for 150-psi steam and condensate traps located below on operating floor



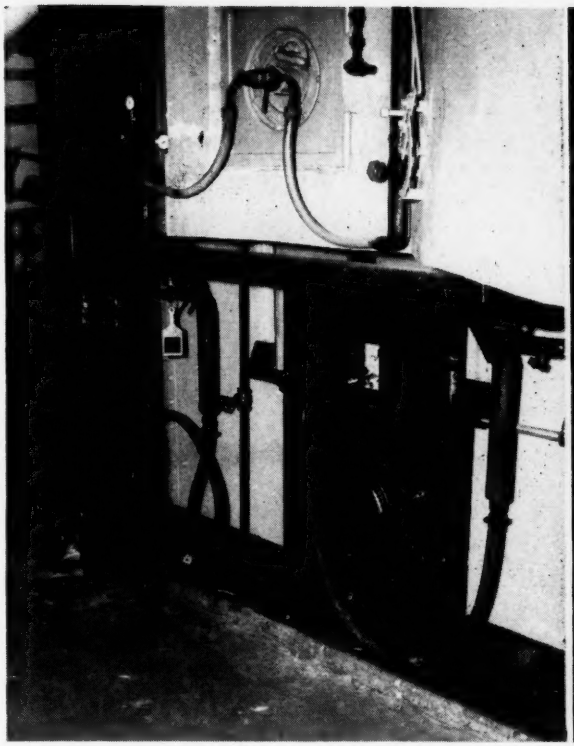


Fig. 6. One of oscillating nozzles through which black liquor is fired in furnace of Warren recovery unit. Above it is one of steam-atomizing fuel oil burners for emergency and supplementary firing

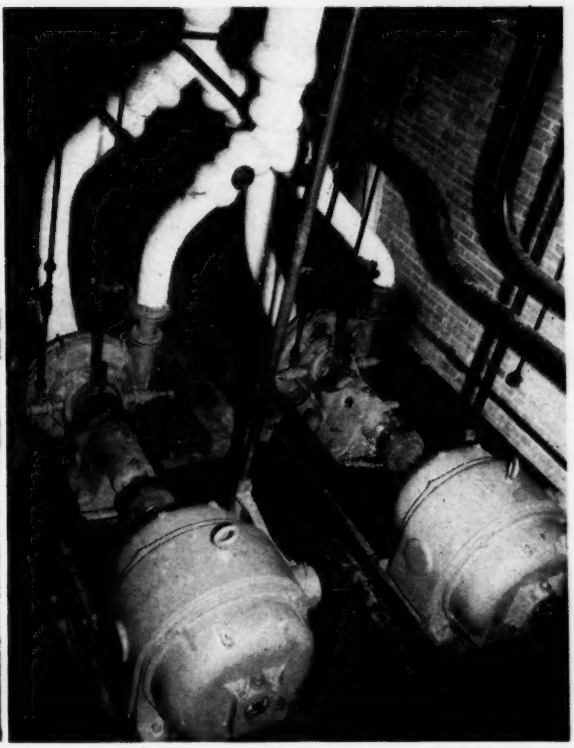


Fig. 7. Black liquor pumps on Warren recovery unit handling liquor containing 81 per cent solids. Note ½-in. steam blowout lines used for cleaning liquor from piping when shutting down

ating heater. This is avoided at present because the 16 low-pressure boilers also take water from the same heater.

Steam Turbine and Process Steam Supply

At present, the steam generated from the recovery boiler is supplied to a 3000-kw non-condensing turbine-generator at 560 psig and 725 F, the turbine exhausting at 36 psig and 330 F. This unit is shown in Fig. 3. The turbine regulator operates from the high-pressure side to maintain constant throttle pressure. Generator output is therefore dependent entirely on the steam production of the recovery boiler. A by-pass around the turbine has been provided with a reducing valve and desuperheating station to reduce steam to 36 psig and 330 F. Most of this 36-lb steam is used in the multiple effect evaporators while some is used for paper machine dryers. The remainder is reduced for makeup to the 10-psi system supplying steam to the deaerating feedwater. These arrangements are shown diagrammatically in Fig. 1.

During the next few months, a 4000-kw non-condensing turbine generator will be installed as in Fig. 1. This will also operate on the 560-psig system but will exhaust at 150 psi. Any excess steam generated beyond the capacity of the two turbines will then pass through two pressure-reducing valves into the 150-psi system after being desuperheated to 385 F.

All auxiliary equipment for the new installation is motor-driven with the exception of the boiler feed pumps and

Fig. 8. Central control panel for new Warren recovery unit is located on operating floor at burner level. One of meters records flow of black liquor to unit, others record steam, combustion air and CO_2. Indicators show steam and feedwater pressures and water level

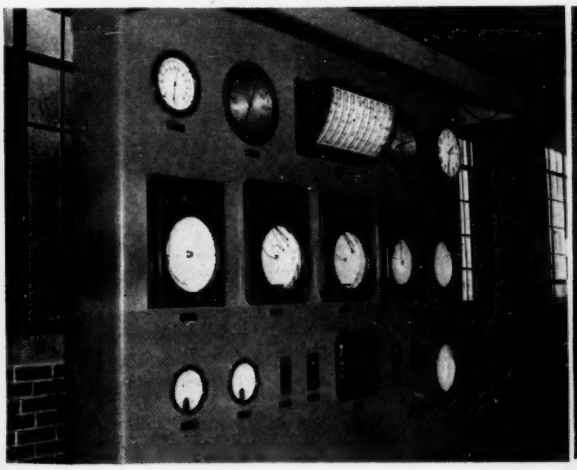
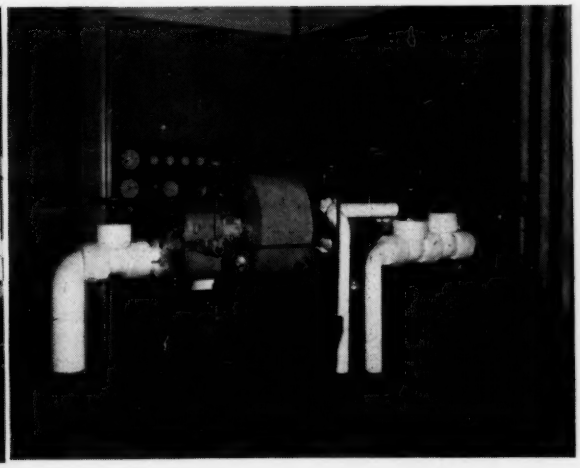


Fig. 9. One of two steam-turbine-driven boiler feed pumps for new Warren recovery boiler, both installed in the turbine room. Each pump designed to deliver 120,000 lb per hr at 210 F against 750 psi head. Pumps driven by quick-starting steam turbines



PRINCIPAL EQUIPMENT—NEW POWER PLANT, S. D. WARREN CO.
Cumberland Mills, Maine

Boiler (1) Combustion Engineering Co. Chemical and heat recovery four drum, bent tube with water walled furnace 480,000 lb dry solids per 24 hr black liquor capacity and 95,000 lb per hr maximum continuous steam evaporation. Design pressure 600 psig in boiler drum. Operating conditions 560 psi and 725 F at superheater outlet. Total heating surface—19,585 sq ft. Furnace width 17 ft 0 in.

Automatic Air-puff Soot Blower System Diamond Power Specialty Co.

Superheater (1) Combustion Engineering Co. Elesco type, to raise steam temperature to 725 F at design conditions.

Air Preheater (1) Aerofin Corp. Steam air heater consisting of nine sections of high pressure heating units for recovery boiler operating on 150 psi pressure.

Induced Draft Fan (1) American Blower Corp. Sirocco No. 8½ double inlet, one half double width with variable-speed hydraulic coupling; max speed 900 rpm.
Drive—200-hp, 2-phase, 2200-v, 900-rpm synchronous motor. Elliott Co.

Forced Draft Fan (1) Buffalo Forge Co. Type 10 SL, single-width, single-inlet for recovery boiler.
Drive—100-hp, 2-phase, 2200-v, 1200-rpm, constant-speed induction motor. Elliott Co.

Turbine-Generator (1) Elliott Co. 3,000 kw, 80 per cent power factor, 3600 rpm, air-cooled generator, 3-phase, 11,000-v, 60 cycles. Horizontal non-condensing turbine with two-row velocity compounded impulse stage, followed by reaction stages, with no extraction. Design conditions are 560 psig and 725 F at throttle. Exhaust at 36 psig and 330 F.

Black Liquor Pumps (2) Worthington Pump and Machinery Corp. Type CH-2, 4-vane impeller with 4 in. inlets, designed for handling corrosive chemicals; nickel iron casing and monel metal impeller.

Deaerating Feedwater Heater (1) Cochrane Corp. Output 400,000 lb of water per hr at zero oxygen content with two minutes nominal water storage capacity.

Boiler Feed Pumps (2) Ingersoll-Rand Co. Horizontally split, 8-stage centrifugal pumps each designed to deliver 120,000 lb per hr at 210 F against a total dynamic head of 750 psig with a net positive suction head of 26 ft.
Drive—quick-starting turbine with a throttle pressure of 560 psi and 725 F; exhausting at 10 psi. Elliott Co.

Air Compressor (1) Ingersoll-Rand Co. Horizontal, 11 x 5 x 11 in.; with intercooler and aftercooler. Constant speed control with free air unloaders and two auxiliary valves—one for 100 lb and one for 250 lb discharge pressure. Actual delivery—253 cfm at 100 lb and 247 cfm at 250 lb pressure. Motor driven.

Steam Separator (1) Consisting of five Hagan purifiers and liquid level control.

INSTRUMENTS AND CONTROLS

Steam flow meters ..... Bailey Meter Co. Republic Flow Meters Co.
Black liquor flow meter ..... Cochrane Corp.
Temperature recorders .... Bailey Meter Co.
Draft gages ..... Bailey Meter Co.
Black liquor heater controls Brown Instrument Co.
Evaporator liquor level control Brown Instrument Co.
Furnace Draft Control . Leeds and Northrup Co.
Recording Ammeters . Westinghouse Elec. Corp.
CO_2 recorder ..... Hays Corp.
Pressure gages ..... Ashton Valve Co. Manning, Maxwell and Moore
Feed Water Control .. Northern Equipment Co.
Pressure Reducing Valves ..... Swartwout Co.
Desuperheaters ..... Swartwout Co.

MISCELLANEOUS

High pressure piping design Sill and Warrington
Valves ..... Edward Valve Co. Crane Co.
Caustic liquor pumps . Warren Steam Pump Co.
Ash dissolving tank pump . Goulds Pump Co.

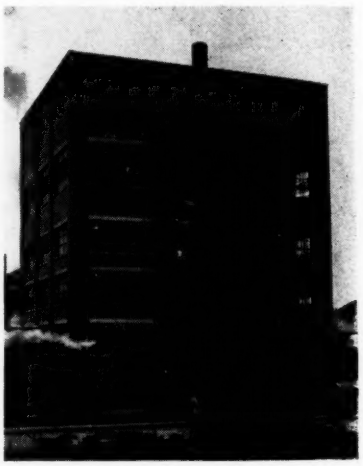


Fig. 10. New building housing Warren recovery unit, showing dissolving tank vent extending through roof

Feedwater treatment ... Hall Laboratories, Inc.
Oil burners ..... Peabody Engineering Corp.
Fuel oil pumps Worthington Pump & Machy. Co.
Emergency Air Compressor ..Ingersoll-Rand Co.
Dissolving tank agitator (Air) Nash Engineering Co.
Safety valves ..... Ashton Valve Co.
Steam traps ..... Armstrong Machine Works
Cascade Evaporator ... D. J. Murray Mfg. Co.
Evaporator reduction gear ..... Falk Co.

the emergency fuel oil pump for the recovery boiler.

The recovery unit has a crew of four men while the turbine has one operator who also operates the boiler feed pumps.

The recovery unit and turbine are shut down for inspection every six months during a mill shut-down period. Aside from these shut-downs, they have been operating continuously seven days a week.

A small emergency air compressor has been installed to cut in automatically at 70 lb if the mill air pressure ever drops below this point. This air-pressure supplies air to all controls and reducing valves on the high-pressure system only.

The boiler, cascade evaporator and black liquor equipment are housed in one building, an exterior view of which is shown in Fig. 10. Turbines, boiler feed pumps, deaerating heater, reducing valves, chemical feed pumps and return condensate and makeup water tank are housed in another about 30 ft away. A three-way telephone line connects the two with the low pressure turbine room.

CORROSION BY WATER AND STEAM

(Continued from page 109)

It is incorporated in the process of hydrogen zeolite softening.

(4) COLD WATER DEAERATION. This process can be used on raw water to remove the free carbon dioxide. It will not, however, greatly affect the bicarbonates and carbonates unless acid is used to first liberate the carbon dioxide.

(5) NEUTRALIZATION OF THE CARBON DIOXIDE IN THE STEAM. Various publications have appeared discussing the qualifications of an ideal chemical for this purpose. The desirable qualifications are that the chemical volatilize steadily from the boiler with the steam and that it dissolve readily and remain dissolved in the condensate. The chemical must of course readily neutralize the carbon dioxide and in so doing not make the steam or condensate objectionable for example, with respect to corrosion of non-ferrous metals or to imparting taste or odor. Needless to say the chemical should be cheap.

The amines have been used with some success from the standpoint of corrosion but their use is very costly and they may impart taste and odor to the steam.

Fortunately a volatile alkaline material is now available that is much cheaper to use and does not impart objectionable taste and odor to the steam or condensate. Also by proper control of its use there is no danger of corrosion of brass, copper or any other metals making up heating systems.

The material is added to the boiler in proportion to the make-up water used. Once treated any steam returned as condensate requires little if any further treatment. If the percentage of return is high, for example over 50 per cent, the material can be added intermittently. Otherwise, it should be added continuously.

A simple pH test can be conducted on the condensed steam to determine whether the correct amount is being used. A pH of 7.5 is satisfactory although there is no danger if the pH is increased to 8.5. Depending on the amount of steam being handled a pH of 6.0 or even 6.5 may be considered from the standpoint of corrosion and treatment should be considered dangerous.

Recent investigations have clarified greatly the aspects of corrosion of condensate piping. Based on this work volatile alkaline materials have been developed that will largely prevent corrosion. The cost of use where large amounts of steam are involved, however, is very high and consequently improvements are to be desired.

It would appear that these improvements must be along the line of eliminating the cause of the corrosion rather than developing a better "cure." With respect to eliminating the causes, proper design of equipment especially as to venting will aid greatly. Improvement in pretreatment of boiler feedwater to remove the source of carbon dioxide and elimination of the use of soda ash in internal treatments, both will greatly decrease the carbon dioxide content of the steam. Finally, there appears to be some chance that better materials can be made available at a reasonable cost for use in such equipment. Some of the newer type "glass" coatings as well as plastic coatings appear to show promise in this respect.

Fuel Crises Heightens Interest in Power Show

PERFORMING a much-needed educational function, the 17th National Exposition of Power and Mechanical Engineering, held December 2 to 7 in the Grand Central Palace in New York City, exhibited many of the war-born advances in metallurgy, instrumentation, specialties and auxiliaries. The record number of visitors attending this year's show had their interest heightened by the current brown-out and their attention was consequently directed most particularly to all fuel and energy conserving devices, controls and instruments and to the revolutionary gas turbine. Receiving a high share of attention, too, were the steam generators, electronic control devices and many metallurgical advances.

One exhibitor, Allis-Chalmers Mfg Co., featured the application of its Betatron to practical radiography. While previously announced through the medium of AIEE transactions, the Power Show was the first opportunity given the engineering public to study, by means of animated display, the application of industry's new seeing-eye.

Revolutionary advances in instrumentation were the electronic instruments for oxygen determination shown by Bailey Meter Co. and Hays Corp. These instruments had been under development for several years and were displayed for the first time at the Show. Provision is made, in one of these instruments, for four continuous line records on the same chart regardless of the purpose for which the chart may be used. The operation of the instrument is based on the para-magnetism of oxygen and it consists of an insulated cabinet in which the temperature is held slightly higher than that of the surrounding atmosphere. (This instrument will be described in detail in a future issue of POWER PLANT ENGINEERING).

Other electronic equipment on display included a resistance thermometer suitable for recording temperatures from minus 300 F to plus 1200 F; a potentiometer pyrometer for recording temperatures in the usual thermocouple range; a telemeter transmitter and receiver which measures the movement of a micrometer screw; and a cut-away model of a bellows-type electronic transmitter for recording liquid level or flow of liquids or gases.

Another exhibitor, Leeds & Northrup Co., showed several recorders—for temperature, conductivity and for separating the records of individual temperatures in multiple-point recording which normally would overlap.

Physical limitations of the booths ruled out display of many of the larger items of equipment but accurate scale models were employed in some instances. As mentioned above, Allis-Chalmers' model which depicted the first 500-kw stationary gas turbine to be constructed in this country attracted the greatest attention. The model was supplemented by a schematic diagram, in color, on glass. Another excellent model represented a central power station complete with steam generator and 500 kw turbine generator.

The trend in many small plants for as-near-as-possible automatic operation and the natural leaning toward "packaged-power" directed a great amount of attention to the steam generators exhibited by Ames Iron Works and Cyclotherm Corp. While not a completely new development the small steam generator had not been exhibited to a wide extent prior to the Show. Cyclotherm had a 60-hp completely self-contained unit with modulating controls exhibited; it was equipped to fire heavy fuel oil.

Among the boiler auxiliaries on exhibition was Cochrane Corp's. high pressure condensate return system which demonstrated the positive drainage provided for power and process equipment. A new and larger pump has been added to this unit and several other changes in bearing and couplings and the reduction of noise by use of a silent jet permits more convenient installation. Another manufacturer exhibited a self-cleaning heat exchanger which can be cleaned while the unit is in operation. Many excellent exhibits of high pressure piping, valves and steam traps were presented.

A combination of two well-known products into a unit which was described as offering complete purification of fuel and lube oils was given considerable prominence at the Exposition by De Laval Separator Co. This manufacturer has combined an oil separator with a filter in order to give the Diesel operator a means of continuously purifying and restoring his lube oil to "like-new" quality and appearance. The purification is done at moderate temperatures with the result that the oil's stability is not impaired by the process.

Several manufacturers told the story of wartime development in metals. The interest in magnesium was heightened by a dramatic display of Revere Copper & Brass Co. which compared the weight of this metal to steel and brass and copper. Another company, Republic Steel Co., exhibited a demonstration model of testing apparatus used on production lines. This tester would take samples of tubing and establish the soundness of the sample when crushed end-on-end. The tester then would subject the test piece to a distortion 100 times greater than would be met in actual installation under normal working conditions.

The steel tubing shown in this display is produced by cold-forming and its qualities render it capable of fulfilling the most exacting specifications requir-

This photo shows a view from the second floor mezzanine overlooking the first floor bay at the 17th National Exposition of Power and Mechanical Engineering

ing stainless steel for condenser and heat exchanger tubing.

One unusual exhibit staged by The Fluor Corp. consisted of a working model of a pulsation dampener, a device that changes pulsative flow into a smooth, steady stream. This pulsative flow, often set up in air, gas or vapor lines wherever reciprocating type compressors are the source of power is lessened by installing these dampeners on either suction or discharge sides of the compressor or both. The display consisted of a small electric driven compressor with dampeners installed on both sides. A lever permitted the spectators to operate the device and route the flow through the dampener or to by-pass it.

The advances in plastics were made evident through the actual mechanization of the displays themselves. Several plastic models of equipment rendered the study of the equipment easier; one example of this was the transparent plastic model dust collector (Buell Engineering) which showed the swirling motion of the dust particles and allowed the observer to note the method of separation. Another plastic demonstration model (The Dampney Co. of America) was a simulated boiler tube which was used for demonstrating a method of applying protective coating which prevents water-metal contact. An Armstrong trap, made of glass, was operating at 5 psi steam pressure.

A variable speed selector, which is designed to provide the exact speed needed for each job, was on demonstration by B. F. Goodrich. The manufacturer pointed out that the unit consisted of two V-belts and four variable pitch pulleys which could provide any speed from full forward down through zero speed into full reverse speed. This is done in stepless, infinite ratio changes without stopping the driving unit to make changes.

A comprehensive display of control valves applicable to practically every industrial field was on display. One new model was an all steel boltless diaphragm motor assembly. One West Coast manufacturer staged an Eastern coming-out party for its new line of flareless couplings developed for use with hard wall or heavy tubing.

A life-size display of high and low pressure chemical feeding equipment for both internal treatment of boiler water and for oxygen removal was presented at another booth by Proportioneers, Inc. Installation was complete in every respect including pumps, valves, piping, storage tanks, timers, and electrical equipment. The spectator was invited to start and stop the equipment, make adjustments in chemical dosages and change time cycles.

One demonstration unit in Keasbey & Mattison's booth for insulation installations was dramatized and animated by a revolving turntable. This manufacturer also presented his corrugated asbestos in a novel manner—the asbestos was incorporated in the design of the display.

Metalock Casting Repair Service attracted considerable attention through excellently done photos of repairs which had been made in places where welding was virtually impossible, and without the use of heat. It was pointed out here that no distortion occurred and that it was not necessary to remove the part from the machine in order to effect its repair.

Telemetering devices appeared in several forms and with many applications as remote controls. Conveyor operation; starting, stopping and "inching" machine tools; and printing, textile, laundry machinery are applications suitable for these controls. A new magnetic switching mechanism was displayed and was mentioned as providing the answer to many difficult and unusual control problems.

The current and growing interest in smoke control and fuel conservation was evidenced by a line of controls being introduced by one manufacturer, Perfex Corp., which will be within the cost range of the small and medium plant.

Sixty-Seventh Annual Meeting of the ASME.

DURING the five days from December 2 to 6, inclusive, the American Society of Mechanical Engineers carried on a continuous round of simultaneous sessions at which problems ranging from the general topics of social and economic conditions to the minutest details of research science were thoroughly discussed. This was the Sixty-Seventh Annual Meeting of the Society and was held in Hotel Pennsylvania in New York City. Affiliated with the Society during this meeting was the First National Convention of the American Rocket Society. The total attendance approximated 5000 which, in numbers, broke all previous records.

Altogether 89 sessions, luncheons and general meetings were scheduled on the program, and the emphasis can well be judged by the fact that eight sessions were devoted to applied mechanics, eight to heat transfer, seven to power, six to oil and gas power, five to fuels, five to aviation, four to metals engineering, four to process industries, three to materials handling, two to boiler feedwater, and two to graphitization, but other divisions of the Society were by no means neglected.

Among the highlights of the meeting were the Annual Dinner for Members where awards and honors were presented, the keynote luncheon on the first day of the meeting which dealt with the Public Responsibility of the Engineer, the Annual Business Meeting, the management luncheon where Paul G. Hoffman spoke on "The Outlook for Freedom," college reunions and plant trips.

In one of his closing remarks as president of the ASME for 1946, Dr. Robert Yarnall told members of the Society that "The desire for collective action seems strong among young engineers in this country, and what form this action should take is a most important question facing the engineering profession today. As good citizens we must no longer sidestep our responsibility in this area." Dr. Yarnall relinquished the office of president of the Society on Friday, the last day of the meeting, to Eugene W. O'Brien, of Atlanta, Ga., managing director of *Southern Power and Industry*.

So important and so extensive was the technical information revealed that time and space limitations prevent publishing in this January issue an adequately comprehensive report of the meeting. Such a report will, however, be printed in the February issue of POWER PLANT ENGINEERING when summaries of papers of interest to power engineers will be given for the benefit of readers.

COMING EVENTS

Heating and Ventilating Exposition—7th International Heating and Ventilating Exposition; to be held January 27 to 31 in Cleveland at Lakeside Hall.

Electrical Engineering Exposition—Annual show (Postponed since 1941) to be held in New York City, January 27 to 31; headquarters at 71st Regiment Armory, Park Ave. and 34th St.

AIEE—American Institute of Electrical Engineers; winter convention to be held January 27 to 31.

Stoker Manufacturers—Conference membership meeting of the Association's members; to be held January 28 at the Carter Hotel, Cleveland.

ASTM—1947 Spring Meeting and Committee Week of the American Society for Testing Materials; to be held in Philadelphia, February 24 through 28, with headquarters at the Benjamin Franklin hotel.

Power Conference—1947 annual meeting, Midwest Power Conference; to be held March 31, April 1 and 2 in Chicago, with headquarters at the Palmer House.

Stoker Manufacturers—Annual meeting of the Stoker Manufacturers' Association to be held June 16, 17 and 18; headquarters to be at Lookout Mountain Hotel, Lookout Mountain, Tenn.

ASTM—1947 Annual Meeting; to be held in Atlantic City, June 16 through 20, with headquarters at Chalfonte-Haddon Hall.

Instrument Society—Instrument Society of America annual meeting; to be held the week of September 8, 1947, with headquarters at the Stevens Hotel, Chicago.

Instrumentation Conference—Instrumentation Conference and Exhibit for 1947; to be held the week of September 8, with headquarters at the Sevens Hotel, Chicago.

NEW SUNVIS "900" TURBINE OILS

The new SUNVIS "900" TURBINE OILS are a postwar development to meet the lubrication requirements of the most modern, high-speed, high-temperature, high-pressure turbines. The life characteristics of these oils are far in excess of present-day demands, and we predict performance equal, or superior, to that of any other turbine oils. We invite the inquiries of public utilities and other turbine operators.

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NEW ENGINEERING BOOKS

Elementary Heat Power, by Harry L. Solberg, Orville C. Cromer and Albert R. Spalding; 480 pages, illustrated; cloth binding; size 6 by 9 in., John Wiley & Sons, Inc., 440 Fourth Avenue, New York City, price $4.75.

Here is a book written especially to fit the post-war curriculum at Purdue University. Mr. Solberg, Head of the School of Mechanical Engineering, Mr. Cromer, Associate Professor and Mr. Spalding, Instructor in the same subject, after analyzing teaching experiences in the Navy V-12 program and their background of many years in teaching heat power engineering, concluded that best results would be achieved by the study first of a course in heat power. In this course, emphasis would be placed on fuels as sources of energy, the functions of the equipment used for power generation, the construction of such equipment and its actual performance. With this background, the student could then be given a one or two-semester course in thermodynamics, in which he could study intelligently the laws that govern the ideal performance of heat power equipment. The book was written from that point of view for students who had a course in college chemistry, who have completed at least one semester of college physics including heat and mechanics, and who are studying or have completed the usual course in integral calculus.

Lest the practicing engineer should be frightened off by the last comment about calculus, we hasten to suggest that he can very profitably read this book, for the amount of calculus used in it is negligible and, except for one or two points, only elementary algebra is needed.

The book should porve useful to students of heat power in or out of college for it discusses the modern power plant and modern equipment and the various fundamental principles that are now well established.

Various chapters cover (1) Matter and Energy, (2) Fuels and Combustion; (3) Internal-Combustion Engines; (4) Fuel-Burning Equipment; (5) Steam Generation; (6) Steam-Power-Plant Cycles; (7) Steam Engines; (8) Steam Turbines; (9) Pumps; (10) Drafts, Fans, Blowers and compressors; (11) Feed-water Heaters and Condensers; (12) The Gas-Turbine Power Plant; (13) Mechanical Refrigeration. At the end of the book are given steam tables for dry saturated steam, both temperature and pressure, and the book is indexed.

• • •

Education for Responsible Living, by Wallace B. Donham; 310 pages, size 5½ by 8½ inches; cloth binding; Harvard University Press, Cambridge, Mass. Price $3.00.

Based on experience of many years as Dean of the Harvard Graduate School of Business Administration, the author issues a challenge to the liberal-arts college to fit men better for life in a changing world. Part I is an appraisal of the present liberal-arts college and a recent study of the factors that prevent it from providing the sort of general education needed for the present age.

Specialization in the world of affairs is necessary but dangerous, says the author. Yet the major problems of industry and government are not technological or even economic questions which arise out of the immediate environment—their origin is social.

Part II is An Attempt to Be Specific. Whether the reader agrees with the author's ideas or not, the suggestions given certainly are specific. He takes up in detail a suggested four-year course in general education that would produce some of the results he says must be produced. He would have mathematics taught thoroughly but in a different way from engineering or scientific mathematics, general science in such a way as to bring out a general understanding of science and its place in human affairs, without slowing the student down to give him the laboratory skills needed by men who intend to become specialists. Courses in contemporary civilization should be based on present-day social problems and should lead to a course in general policy. The study of history should start at present-day problems and trace their development and their solutions through the ages. Life does not go on in separate water tight compartments and the policies of men are influenced by the impact of science, economics and social feelings. The book concludes with a chapter on Science, Social Science, Human Relations and the Humanities and Their Interdependence, and another on Academic Authority, Leadership and Responsibility.

• • •

Boilers and Combustion, 1944, Publication No. M4; 62 pages, illustrated, size 8½ by 11 in., paper bound; A Report of the Boilers and Combustion Subcommittee of the Prime Movers Committee, Edison Electric Institute, 420 Lexington Avenue, New York 17, N.Y. Price $1.00 to members, $2.50 non-members and $2.65 foreign countries.

This report, the latest available from the above subcommittee, contains data from operating companies on pressure parts, boiler cleaning, performance, maintenance and furnace-tube corrosion.

Difficulties in connection with pressure parts do not appear to have been serious. External cleaning continues to be a major problem. Need for internal cleaning is reported in many cases but improved methods of feedwater and boiler water treatment have greatly reduced the seriousness of this problem. Chemical cleaning is being used more extensively with satisfactory results in most cases.

Many burner changes have been made to obtain better distribution of the products of combustion. Poorer quality of coal has caused some difficulties which are discussed in considerable detail.

Statements from manufacturers give details of boiler cleaning equipment, dust collectors, boilers, superheaters, furnaces and air heaters, acid cleaning, forced-circulation boilers, twin furnace units, steam temperature control, oil and gas burning equipment and stokers.

• • •

The Modern Gas Turbine, by R. Tom Sawyer, 216 pages, illustrated, 6 by 9 inches, cloth binding, Prentice-Hall, Inc., 70 Fifth Avenue, New York, New York. Price $4.00.

In this book Mr. Sawyer has injected some "unity, coherence and emphasis" into the discussion of the gas turbine that has been going on throughout the technical fields for the past four or five years. During that period, as our readers know, POWER PLANT ENGINEERING and a great many of the other technical magazines have been publishing a veritable flood of material including details of the work of industrial companies manufacturing gas turbine equipments such as Brown-Boveri, Escher-Wyss, General Electric, Westinghouse, Elliott and Allis-Chalmers; the analyses of cycle-efficiencies and performance in the well-known paper of Soderberg and Smith; reports on the service records of the Houdry gas turbo compressors, the work in developing the coal burning gas turbine locomotive by Yellott; etc.

But the student of the subject needs something more than this—a synthesis and clarification of all this material. Mr. Sawyer, from his point of vantage as an engineer of Diesel equipment for American Locomotive Co., intimately connected with the development of turbo superchargers during the war, has provided this synthesis.

The book begins with a short historical introduction, then continues with a discussion of the fundamental principles of the gas turbine. The next section deals with early inventions and history of the gas turbine.

Many of the early ideas about modern superchargers and gas turbines were for using them in connection with Diesel engines and a good discussion of this subject on the gas turbine using exhaust gases as a supercharger or as a prime mover is presented. Then comes a detailed treatment of combustion gas turbine calculations and efficiencies following the lines indicated by Soderberg and Smith.

The chapter on the gas turbine in industry describes Houdry units, the Velox power plants, the bombproof gas turbine power station at Neufchatel, Switzerland, the experimental pulverized-fuel-fired turbine at Baden, Switzerland, open and closed circuit gas turbines. Subsequent chapters deal with the gas turbine in marine service and with the gas turbine locomotive, although at the time the book was written, nothing could be said about the Elliott and Allis-Chalmers machines built for the Navy, on which data have since been reported in the technical press. Also when the book was written the coal-burning gas turbine locomotive work of Yellott had not yet begun.

Now that Mr. Sawyer's book has provided a foundation of data on the modern gas turbine itself, the next step, as Joseph H. Keenan points out, should be the preparation of a textbook or treatise expounding this new field of gas-turbine in terms of the fundamental sciences of engineering. Preparation of such a treatment is now under way.

• • •

Boiler Auxiliaries 1944-1945, Publication No. M6, 40 pages, illustrated, size 8½ by 11 in., paper bound. A Report of the Boiler Auxiliaries Subcommittee of the Prime Movers Committee, Edison Electric Institute, 420 Lexington Avenue, New York 17, N. Y. Price 70 cents, members; $1.75, non-members, and $1.90 foreign countries.

Section I of this valuable publication discusses boiler feed pump corrosion-erosion investigation and states that the great majority of trouble cases are being corrected by the installation of alloy steel parts or by depositing alloy filler metal on existing carbon steel parts.

Section II reports the results of a study initiated to help in the selection of proper draft fan sizes for power station boilers. Section III reports the experience of 30 operating companies in induced draft fan maintenance.

Magnetic couplings are discussed in detail in Section IV. Sections cover automatic feedwater level regulators and automatically operated soot blowers. Coal handling equipment is treated in detail.

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Basic Principles of Writing, by W. Otto Birk, Frederick William Holmes, Harold Wesley Melvin, Joseph Lee Vaughan; 457 pages, size 6 by 9 in., cloth; second edition; Pitman Publishing Corporation, 2 West 45th Street, New York. Price $2.00.

In this well-known text on composition, four definite objectives were set: (1) Presentation of the principles underlying good writing; (2) Practical instruction in composition; (3) Elimination of Common faults in writing; and (4) Liberation of the student's power of expression. The authors have approached the subject from the constructive rather than the analytical point of view, so far as is practicable.

Although they devote much attention to the first three objectives, the authors try to attain the fourth by showing that it depends on the student's approach to it as a problem in thinking and in the expression of thought.

While the book is not devoted primarily to engineering writing, but rather to general principles applicable to any writing, it should prove particularly useful to the junior technologist because of this emphasis. The chapter on controversial writing is good and Part III of the book, covering the last 120 pages, consists of a handbook covering the mechanics of writing with careful instructions on how to use it and detailed index of the points covered in it.

• • •

Units of Weights and Measures, by Walter Renton Ingalls; Copyright 1946; 5½ by 8½; 49 pages; paper bound; published by the American Institute of Weights and Measures, 33 Rector Street, New York 6, New York. Price $1.00.

Starting out with a short dissertation on units of the English system in practical use, the author states that it is his purpose to compose a glossary with amplifications of units and measures that are of general interest and in respect of which inquiries come to the office of the American Institute of Weights and Measures. The terms discussed are arranged in alphabetical order and deal with such items

(*Continued on page 144*)

WHAT YOU FACE IN BUYING STEEL VALVES IN 1947

An Annual Report to Steel Valve Users

IT'S BEEN FIVE YEARS since most types of steel valves have been readily obtainable on short deliveries. What is the outlook now?

In general, the situation is much better on small valves, and just about as tight, or perhaps even tighter, on large valves.

WHY SHOULD THAT BE?

The principal reason is that throughout the war the Navy and Maritime Commission were just about the biggest users of steel valves. Marine power plants usually run to smaller sizes than land power plants. Therefore, the smaller sizes of steel valves were in very short supply.

Since the end of the war, construction of land facilities has increased substantially. With that has come a great demand for the larger sizes of valves.

MORE LEAD TIME

LARGE VALVES require more lead time in the procurement cycle. For the higher pressures and temperatures particularly, they are not usually stocked and production runs are necessarily shorter.

Of course, even in the smaller sizes, "specials" take time. Standard valves are in regular production, and while requirements are still so heavy that a few large orders may all but wipe out available stocks, they come through regularly with normally little delay. Special flange facings, materials or design changes greatly retard deliveries, however.

SO, WE SUGGEST THAT SO FAR AS POSSIBLE, YOU...

1. *Place orders, particularly for large valves, well in advance of requirements.*
2. *Avoid specials.*

NEW OPERATING CONDITIONS

THERE IS A DISTINCT TREND in nearly every service for which steel valves are used, toward higher pressures, higher temperatures, or a combination of the two.

Many new valve designs have been introduced to meet these new requirements. Edward, a pioneer in steel valve development, has done a great deal of research and design work on welded bonnet valves, pressure sealed bonnet valves, re-contouring of bodies for lower pressure losses, high alloys for temperature extremes and welded lines, and many construction details.

To take full advantage of these advancements, some of which are not yet fully covered in catalogs and sales promotion material, we suggest that you give us an opportunity to work with you in the early stages of any expansion program you plan.

COMBINED RESEARCH FACILITIES

There has been great progress in steel valve research during the past few years. Much specific data on valve installation and operation, never before available, is now in our files.

Furthermore, as a unit in the Rockwell Manufacturing Company, Edward has access to the research and engineering departments of a number of other plants, most of them serving related fields.

Often, we can help you with problems which you face. Don't hesitate to call upon us. Our laboratories and engineering research departments are operated not for development alone, but for customer service as well.

LESS PRESSURE ON RAW MATERIALS

LONG RANGE PREDICTIONS are at this time very difficult, particularly in view of the uncertain labor outlook. Barring extensive plant closings in key industries, however, we feel that steel valve raw material shortages will be only spotty and not of long duration. Labor supply, though, particularly in the skilled categories, keeps us from approaching maximum output.

It appears that the demand for steel valves will be quite extensive for most of 1947 at least. A sufficiently large number of major projects are under way or definitely projected to assure that. As a matter of fact, shortage of consulting engineering time seems to be all that is holding up many more projects.

You will therefore, we feel, be the gainer to anticipate your steel valve requirements as far into the future as possible. Whether it be for boiler room, petroleum, industrial, technological or marine service, if steel valves are required, Edward can help you. In size range we build valves from ⅛ in. to 14 in., and in pressures, we build valves for services from 150 psi up.

W. F. Crawford
President

Edward Valves, Inc.
SUBSIDIARY OF
ROCKWELL MANUFACTURING COMPANY EAST CHICAGO, INDIANA

NEWS *from* THE FIELD

WHITEHEAD MIDWEST POWER SECRETARY

DR. EDWIN E. WHITEHEAD, recognized power authority, has been appointed secretary of the Midwest Power Conference, Stanton E. Winston, Director, announced this week.

Dr. Whitehead, who was recently appointed research professor in Illinois Institute of Technology's electrical engineering department, will succeed Charles A. Nash, IIT professor, who has had a seven year tenure in office. Dr. Whitehead has been associated with the Duquesne Light Co. for the past fourteen years as research supervisor, operating engineer, investigating engineer, and general engineer. An alumnus of the University of Colorado and the University of Pittsburgh, he is well-known for his work in lightning studies and system studies.

NAIL SHIPMENTS NEAR RECORD RATE

IF UNINTERRUPTED, the current high rate of nail shipments should in a few months relieve the widely reported shortage of this product, especially for the housing program, according to the American Iron and Steel Institute. During September nail shipments were equivalent to the highest peacetime annual rate since 1923, when 789,000 tons of nails were shipped. The total for September at 59,875 tons represents an annual rate of shipments at approximately 720,000 tons.

A major reason for the current nail shortage has been the prolonged effect of the loss of over 50,000 tons of wire nail and staple production in early 1946 because of strikes. Since the strikes, nail shipments have fared relatively well in relation to other steel products. Although the industry's potential steel production during the first nine months of 1946 was cut by 25 per cent due to strikes, nail shipments were only 6 per cent below the comparable months of 1945 and 1940.

STOKER MANUFACTURERS' BOARD MEETING

THE BOARD OF DIRECTORS of the Stoker Manufacturers' Association met in Chicago recently and took the following action:

Selected the date and place of the annual meeting of the Association, which will be at the Lookout Mountain Hotel, Lookout Mountain, Tennessee, on June 16, 17 and 18, 1947.

Selected the date and place of the next conference membership meeting of the Association's members which will be at the Carter Hotel in Cleveland, Ohio, on January 28, 1947. This is during the week of the International Heating and Ventilating Exposition at which time numerous other national trade associations in the heating industry will hold annual or semi-annual meetings;

Appointed F. J. Kluempers, Manager, Stoker Division, Fairbanks, Morse and Co., Chicago, as a member of the Board of Directors to fill a vacancy created by the resignation of J. H. Simpson, of Manheim, Pennsylvania, who recently resigned his position of vice president of the Hershey Machine and Foundry Co. Mr. Simpson's resignation as chairman of the Association's Anthracite Section was also accepted and a successor to this position will be chosen at the next meeting of that division of the organization, probably at Cleveland late in January.

Approved a standard warranty on stokers and recommendations on service guarantees which will be presented to the membership for adoption or rejection at the late January meeting of the Association's members;

Appointed a special committee of management and engineering executives to meet with officials of Bituminous Coal Research, Inc., for the purpose of discussing possible research projects which may be carried on by the Bituminous coal industry's research organization for the mutual benefit of the coal and stoker industries.

STEEL BUILDING STANDARDS ANNOUNCED

OFFICIAL INDUSTRY standards for light gage steel which will make possible broader uses of the material in certain types of building construction, were announced recently by the American Iron and Steel Institute.

The comprehensive "Specification for the Design of Light Gage Steel Structural Members," issued by the Institute, is the result of studies begun in 1939 under the Building Code Committee of the Institute.

According to B. L. Wood, Consulting Engineer of the Committee, research work has been carried on intensively and continuously at Cornell University for more than seven years, under the direction of Dean S. C. Hollister of the College of Engineering, Professor W. L. Malcolm, Director of the School of Civil Engineering and Dr. George Winter, Associate Professor of Civil Engineering, in immedate charge of research.

The program has had as its objective a study of the behavior of light steel structural members under load and the proper proportioning of such members. It has included a study of available engineering literature on the subject, supplemented by tests on beams, studs or light columns and panel or deck constructions involving nearly 700 structural specimens.

R. E. Zimmerman is chairman of the Building Code Committee, of which a technical subcommittee under the chairmanship of Milton Male directed the research work and prepared the Specification.

NEMA ANALYZES ELECTRICAL CODE

THE NATIONAL ELECTRICAL MANUFACTURERS ASS'N has just published a comprehensive analysis of the revisions made in the 1940 National Electrical Code. These revisions are incorporated in the 1947 edition of the Code, copies of which will soon be made available by the National Board of Fire Underwriters.

The new National Electrical Code contains more new material than does any previous edition. There are two completely new articles—one on Electric Welders and one on Machine Tools—and no less than eight articles have been entirely rewritten. In addition, many changes of considerable importance have been made throughout the Code.

NEMA, since 1931, has published analyses of the changes incorporated in new editions of the National Electric Code. These analyses were well received and are believed to have been of service to the electrical industry. The analysis of the forthcoming edition of the Code has been prepared by Arthur L. Abbott of the NEMA Engineering Department.

KINZEL TO HEAD ENGINEERING FOUNDATION

THE ENGINEERING FOUNDATION, at the annual meeting of its Board, re-elected Dr. A. B. Kinzel, internationally known metallurgist, as Chairman for the coming year. Dr. Kinzel is Vice President of the Union Carbide and Carbon Research Laboratories, Inc., and of the Electro Metallurgical Co. During the war he was senior consultant of the Metals Branch of the War Production Board, and Chief Consultant on Metals to the Enemy Branch of the Foreign Economic Administration. His activities extend to the professional technical societies including the International Commission for Acetylene and Welding, and the Committee on Metals of the National Academy of Science.

Other officers elected were: Dr. L. W. Chubb, Director of the Westinghouse Research Laboratories, as Vice Chairman; Dr. Edwin H. Colpitts, formerly Vice President of the Bell Telephone Laboratories, re-elected Director: and John H. R. Arms, re-elected Secretary. Dr. Kinzel will represent the Engineering Foundation on the Executive Board of the National Research Council.

COONLEY, GERARD HEAD NEW I.S.O.

HOWARD COONLEY, chairman of the Executive Committee of the American Standards Association has been elected president of the new International Organization for Standardization, the formation of which has just been completed by delegates from 25 nations meeting in London.

Gustave L. Gerard, staff president of the Belgian Standards Association will be vice president of the new international organization which is expected to be known informally as ISO.

VALVE PRACTICE RECOMMENDATION

THE STANDING committee in charge of reviewing and revising Simplified Practice Recommendation R184-42, Iron Body Valves, has approved a revision of the recommendation, and the Division of Simplified Practice of the National Bureau of Standards has mailed copies to all interests for approval or comment or both.

The proposed revision applies to the usual types of iron gate, globe, angle and check valves for primary pressures of 25-, 125-, 150- and 250-lbs, and 100- and 800-lb. pressures for water, oil and gas. A simplified range of sizes is given for the various types and kinds of valves for each of the pressure ratings.

AIMME ELECTS 1947 OFFICERS

ABLE ENGINEERS from every division of the mineral industry make up a well-rounded roster of the officers who will direct the activities of the American Institute of Mining and Metallurgical Engineers during the coming year. Clyde E. Williams, director of the Battelle Memorial Institute at Columbus, Ohio, was elected president of the Institute for 1947 at a meeting of the Board of Directors held in New York City recently. Mr. Williams was proposed for election by the unanimous vote of the Nominating Committee.

Dr. A. B. Parsons, secretary of the AIMME, also announced the election of two vice-presidents: Andrew Fletcher, vice-president of the St. Joseph Lead Co., New York City; and Robert W. Thomas, general manager of the Nevada Consolidated Copper Corp., Ray, Arizona.

Six directors also elected were: Oliver Bowles, chief of the Nonmetallic Economics Division of the U. S. Bureau of Mines, Washington, D. C.; Arthur John Blair, chief geologist of the Tennessee Coal, Iron and R. R. Co., Birmingham, Ala.; William W. Mein, Sr., president of the Calaveras Cement Co., San Francisco; C. V. Millikan, chief production engineer for the Amerada Petroleum Corp., Tulsa, Okla.; Earle E. Schumacher, chief metallurgist for the Bell Telephone Laboratories, Murray Hill, N. J.; and John R. Suman, vice-president of the Standard Oil Co. (New Jersey), New York City.

SMOKELESS OPERATION OF STOKERS

IN LINE WITH a long established policy to encourage and assist in the abatement of atmospheric pollution Stoker Manufacturers' Ass'n has announced the release of a new publication entitled "Factors Affecting Smokeless Operation of Underfeed Stokers." This four-page folder, prepared by the Association's Engineering and Research Committee discusses, primarily, the various installation factors to be considered for smokeless operation of underfeed stokers burning bituminous coal. Stoker operation, safety provisions and other considerations are also briefly covered.

The discussion begins with a statement that its purpose is "to further the interest of smoke abatement and public safety through a better understanding" of these factors. It is pointed out in the discussion of stoker setting heights that frequently "adequate care is not given to the coordination between this factor and others of equal importance such as boiler or furnace design, ash storage space and cleaning conditions to obtain an installation that will give best overall performance." The importance of these and other factors and their relationship to each other is clearly explained.

Single copies of the publication are available at 5c per copy; lower prices in quantity lots. Address the Stoker Manufacturers' Association, 307 North Michigan Avenue, Chicago 1, Illinois.

(*Continued on page 134*)

INDUSTRIAL WATER CONDITIONING

FOR BOILER AND PROCESS

Only through

CHEMISTRY PLUS ENGINEERING

will you get

CORRECT WATER TREATMENT

The actual Chemical treatment is only part of the picture . . . there must be the careful study of Boiler Design, Operation, Application, Control. Upon the many, varied and complex problems of Industrial Water Conditioning BIRD-ARCHER Engineers, Chemists and Laboratory Technicians bring to bear the cumulative experience of more than sixty years . . . to the end that your specific water conditioning problems may be properly solved.

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SURVEYS • PLANT STUDIES • SUPERVISORY SERVICE
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REDUCING VALVES *for Process Steam*

JIM — *Leslie Representative*
STAN — *Young Engineer*
TOM — *Plant Supervisor**

" . . . and, Stan, when process departments suddenly call for steam, regulators and controllers not only have to react quickly, but very accurately, if you're going to keep the quality of the product uniform."

Stan: **"But, how can you get a reducing valve to meet such severe conditions?"**

Tom: **"Well, here's an example. This LESLIE Reducing Valve reduces our boiler pressure at 450 lbs. and 510° total temperature to 160 lbs. for our main processing steam line. When our different process departments call for steam it opens up *fast*. And, it shuts down fast, too, when the demand drops off."**

Stan: **"What type is it?"**

Jim: **"It's a self-contained, internal pilot, piston operated valve, with a metal diaphragm. Both the main valve and pilot valve are single seated and close with the inlet pressure. So, you can always be sure the valve will be tight, even in dead-end service."**

Stan: **"How do you make adjustments for reduced pressure?"**

Tom: **"Just turn the handwheel, which changes the compression on the adjusting spring and metal diaphragm, then watch the pressure gauge until you get the pressure you want."**

Jim: **"You see, the adjusting spring inside acts on top of a metal diaphragm and is opposed by the reduced pressure. If the reduced pressure attempts to vary, the diaphragm repositions the controlling valve and the main valve reacts instantaneously."**

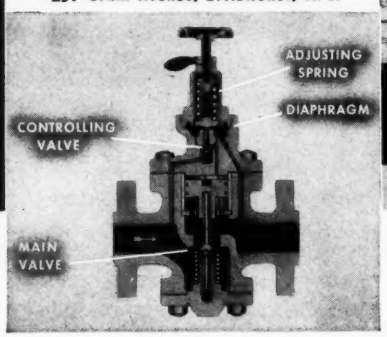
Tom: **"It's the fastest-acting, most dependable valve on the market today."**

Pressure Reducing Valve for main process steam line.

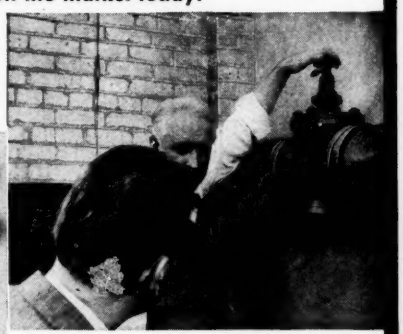
**Scenes and characters from new* LESLIE *sound slide film entitled "Automatic Pressure and Temperature Control."*

TRADE LESLIE MARK

257 Grant Avenue, LYNDHURST, N. J.



Cross section of LESLIE cast steel Pressure Reducing Valve.



Handwheel setting of reduced pressure.

***Write for* new illustrated Bulletin 461 *describing* LESLIE Pressure Reducing Valves.**

Look for LESLIE REGULATORS under "Valves" or "Regulators" in your classified telephone directory in the following cities where LESLIE factory trained engineers are located:

ESTABLISHED 1900 LESLIE CO.

Atlanta, Ga.	Greenville, S. C.	Philadelphia, Pa.	Seattle, Wash.
Baltimore, Md.	Houston, Tex.	Pittsburgh, Pa.	St. Louis, Mo.
Boston, Mass.	Kansas City, Mo.	Portland, Ore.	Syracuse, N. Y.
Bridgeport, Conn.	Los Angeles, Cal.	Providence, R. I.	Toronto, Ont., Can.
Buffalo, N. Y.	Louisville, Ky.	Richmond, Va.	Troy, N. Y.
Chicago, Ill.	Milwaukee, Wis.	Rochester, N. Y.	Tulsa, Okla.
Cincinnati, Ohio	Montreal, Que., Can.	Rutherford, N. J.	Vancouver, B.C., Can.
Cleveland, Ohio	New Orleans, La.	San Antonio, Tex.	Wilkes-Barre, Pa.
Dallas, Tex.	New York, N. Y.	San Francisco, Cal.	Youngstown, Ohio
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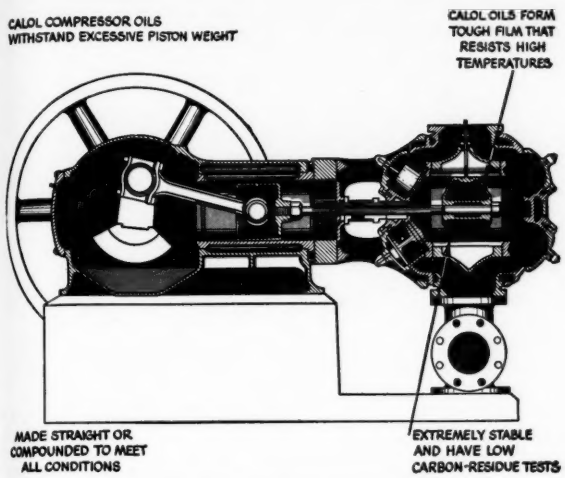
PRESSURE REDUCING VALVES • PUMP GOVERNORS • PRESSURE CONTROLLERS
TEMPERATURE REGULATORS • SELF CLEANING STRAINERS • LESLIE-TYFON WHISTLES

STANDARD ENGINEERS NOTEBOOK

CALOL RPM


CALOL COMPRESSOR OILS WITHSTAND EXCESSIVE PISTON WEIGHT
CALOL OILS FORM TOUGH FILM THAT RESISTS HIGH TEMPERATURES
MADE STRAIGHT OR COMPOUNDED TO MEET ALL CONDITIONS
EXTREMELY STABLE AND HAVE LOW CARBON-RESIDUE TESTS

SINGLE-STAGE AIR COMPRESSOR WITH OIL-TIGHT CRANKCASE

Special oils up air compressor efficiency

Many operators have increased air delivery from compressors by lubricating cylinders with specially-made Calol Compressor Oils.

To meet both dry and moist operating conditions, in all type compressors there are two grades. Both withstand high pressures and temperatures.

Calol Compressor Oil—19 is a straight mineral oil. Pale in color, it is very stable and correctly lubricates under pressures up to 150 pounds per square inch.

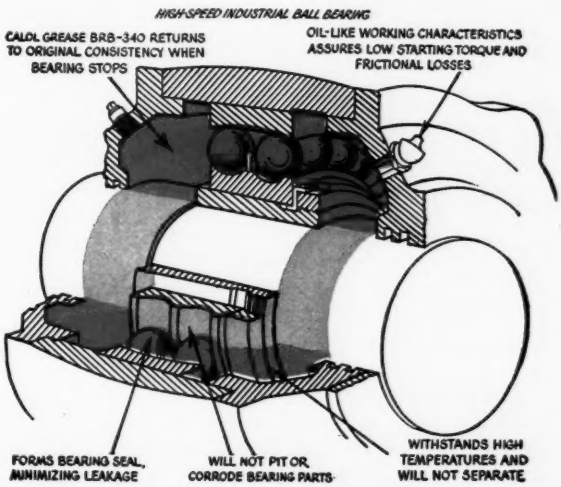
Calol Compressor Oil—19X is compounded and completely resists the washing action of moist air on the cylinders of machines operating in humid surroundings. It is particularly adaptable to large horizontal compressors, where piston weight is a factor, and to compressors on air-injection Diesel engines.

New Calol grease softens and resets

Where anti-friction bearings operate in severe conditions of temperature and speed, newly developed Calol Grease BRB-340 allows easy starting and reduces running friction to a minimum. At high shear rates, its apparent viscosity approaches that of its oil component. However, undue leakage from bearings is prevented by the peculiar ability of Calol Grease BRB-340 to reset, which causes the excess grease, swept aside by balls and rollers, to form a partial seal.

Calol Grease BRB-340 is soft, smooth and has a fine fibrous texture. It is milled by a special process that eliminates bleeding although it contains an unusual amount of oil stock.

When undergoing severe tests, Calol Grease BRB-340 showed no separation in a bearing operating 10,000 RPM at 200° F. for 528 hours. At the end of the test the bearing was in good condition.


HIGH-SPEED INDUSTRIAL BALL BEARING
CALOL GREASE BRB-340 RETURNS TO ORIGINAL CONSISTENCY WHEN BEARING STOPS
OIL-LIKE WORKING CHARACTERISTICS ASSURES LOW STARTING TORQUE AND FRICTIONAL LOSSES
FORMS BEARING SEAL, MINIMIZING LEAKAGE
WILL NOT PIT OR CORRODE BEARING PARTS
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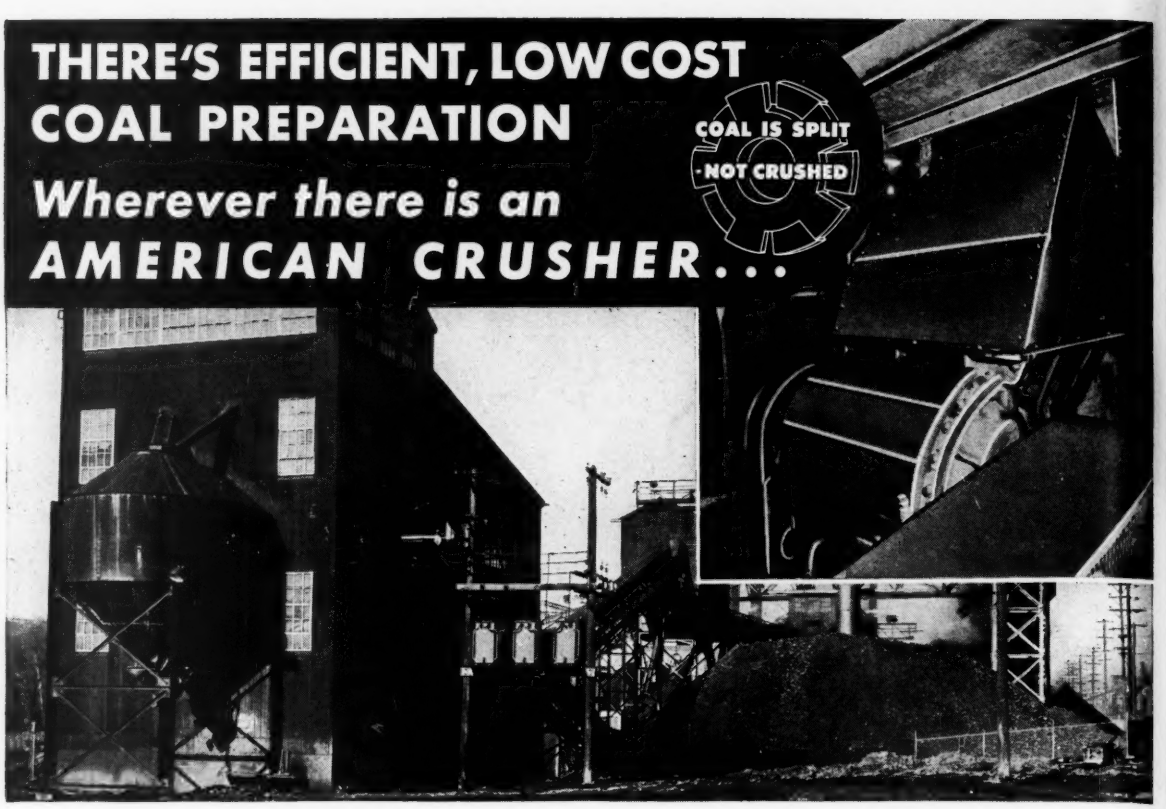
FOR EVERY NEED A STANDARD OF CALIFORNIA JOB-PROVED PRODUCT

THERE'S EFFICIENT, LOW COST COAL PREPARATION

Wherever there is an AMERICAN CRUSHER...

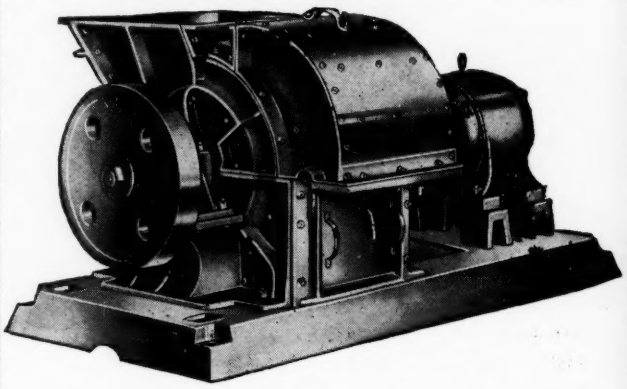


At the Windsor Power House Coal Co., Power, W. Va. preparation plant shown above, the American Rolling Ring Crusher Model 42S (in insert) is in daily operation reducing 5 x ¾" coal to—¾" at the rate of 230 TPH.

Throughout the country, in the many plants with American Crusher installations, you'll find efficient coal crushing resulting in efficient firing.

American Rolling Ring Crushers, with their patented shredder ring action which *splits coal instead of crushing it*, assures uniform sizing. Fines are controlled to a minimum or maximum and no oversize is passed. The crushed product is a constant yield of stoker or pulverizer size.

The *total operating cost* of Americans is *less than 1c per ton.*



The American "S" Crusher for power plants is a compact, complete crushing operation which is installed in minimum head room without extensive conversion and with no auxiliary crushing facilities.
There is an American Rolling Ring Crusher to fit your needs. Capacities up to 500 TPH.

Write for Bulletin "Crushing Coal at Less Than One Cent a Ton"

American PULVERIZER COMPANY

Originators and Manufacturers of Ring Crushers and Pulverizers

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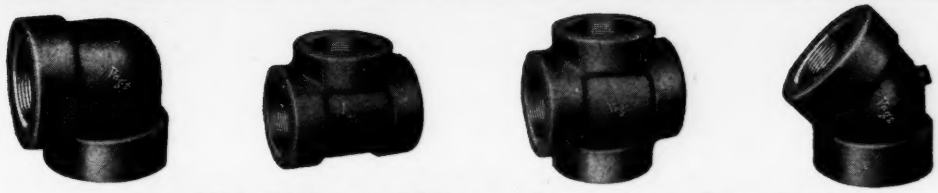
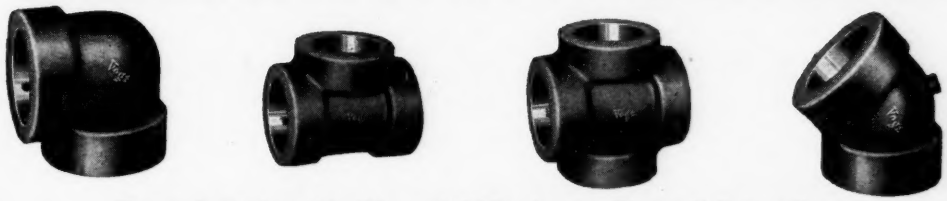
STRENGTH

for Safety and Long-Time Service



For 2000, 3000 and 6000 pounds service — Sizes 1/8" to 6"

SCREW END TYPE



For schedules 40, 80 and 160 pipe — Sizes 1/8" to 4"

SOCKET WELD TYPE

Vogt Ells, Tees, Crosses, etc., are forged from carbon steel or various alloys to meet specific operating conditions. Catalog F-8 will aid you in their selection and proper application.

Shocks and stresses imposed by high pressures and high temperatures are taken in their stride because Vogt fittings are uniform in structure, fine grained, and free from porosity . . . the superior product of laboratory controlled materials and giant forging hammers and upsetters. These properties also give higher resistance to erosive and corrosive conditions, thereby adding to service life expectancy in steam plants, petroleum refineries, chemical plants and related industries.

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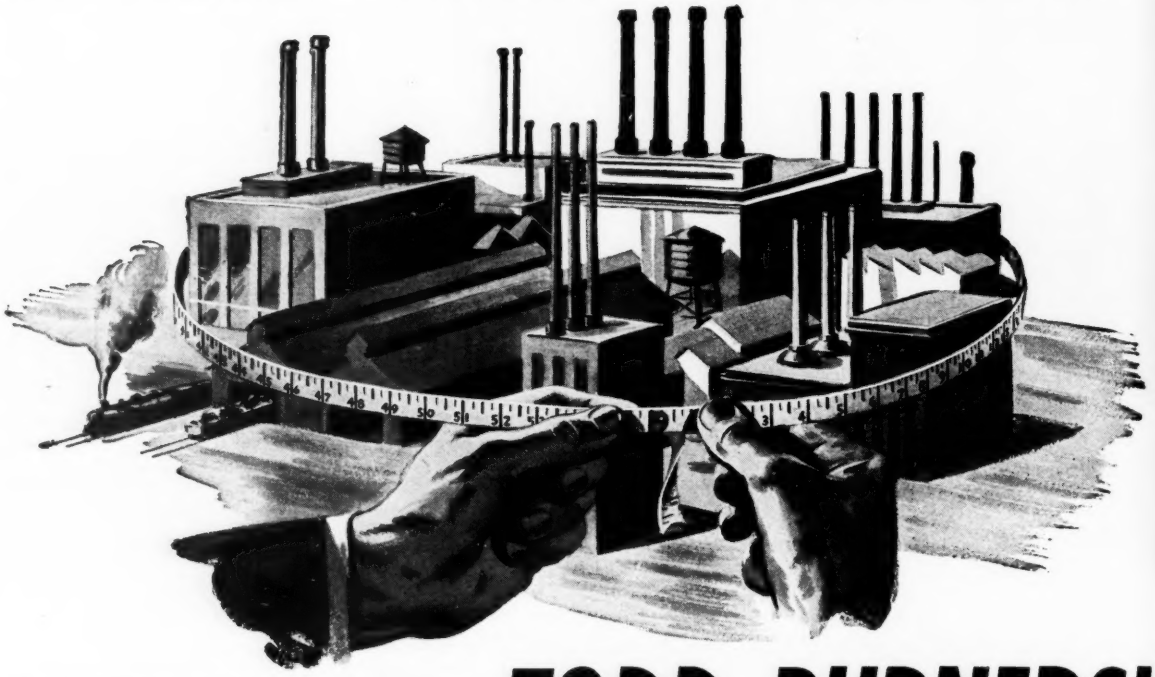
Vogt
DROP FORGED
STEEL FITTINGS

REDUCE THAT POWER "WASTE-LINE"



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IN MANY plants there is a "waste" that has gone unrecognized, year after year — a waste of fuel caused by inefficient combustion.

Today — when a reduction in operating costs can be an important element in holding down prices to meet competition — more and more plant managers are turning a critical eye upon their heat and power set-ups.

When you modernize your boiler room with Todd Oil or Gas Burners, you lay a solid foundation for heat and power economy.

Todd Burners — in case record after case record, which our engineers can show you — have cut fuel consumption as much as 10%, *or more.* At the same time power *capacity* was greatly stepped up and maintenance costs held to a minimum.

A Todd engineer will help you trim that power "waste-line." Many standard and modified types of Todd Burners are available and each job is individually engineered to provide the right application for the heat and power requirements of any industrial or commercial installation.

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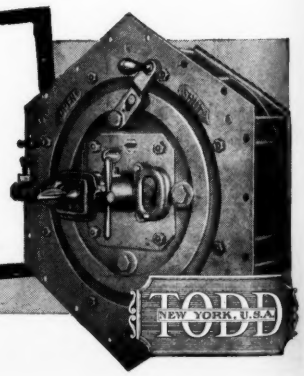
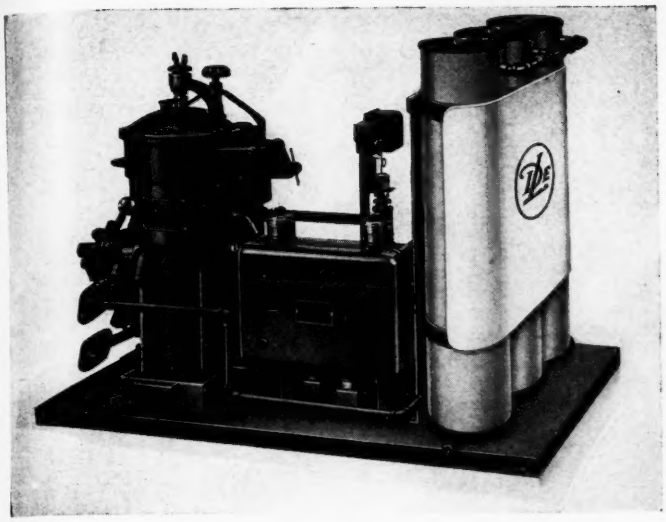




NEW-

DE LAVAL "PURI-FILTER"
FOR PURIFYING DIESEL LUBE OIL

Centrifugal Purification PLUS Micronic Filtration

Note these Features

1. Removes dirt and water by centrifugal force
2. Filters out harmful carbon
3. Does not remove valuable additives
4. Cleans oil at moderate temperature
5. Speeds up inspection—crankcase is cleaner
6. Minimizes ring sticking
7. Increases bearing life
8. Saves labor—long runs without bowl cleaning
9. Increases oil life
10. No dirt . . . carbon . . . or water

THE De Laval "Puri-Filter" is a combination of the De Laval "Uni-Matic" Oil Purifier and the Fram "Filcron" Filter. The unit is complete with dirty-oil and clean-oil pumps, and is piped, ready to operate. Electrical controls are provided, and all parts are compactly mounted on a sturdy metal base.

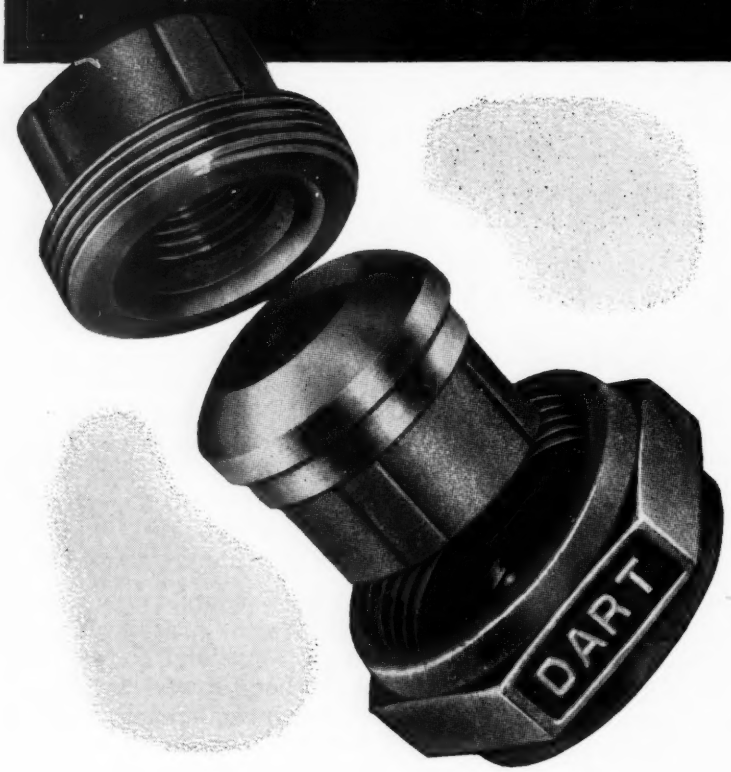
The De Laval "Puri-Filter" enables the Diesel operator to secure the advantages of purifying Diesel lubricating oil by centrifugal force ***and*** by positive filtration. Heretofore he has been forced to choose between centrifugal force, which removed most solid impurities and all water, and filtration, which in cleaning the oil also restored a good measure of color, but which provided no protection against water. With the "Puri-Filter", Diesel lubricating oil can be maintained truly ***clean*** and ***dry***—the maximum in protection for every engine. Ask for Bulletin D-1.

THE DE LAVAL SEPARATOR COMPANY
165 Broadway, New York 6 427 Randolph St., Chicago 6
DE LAVAL PACIFIC CO., 61 Beale St., San Francisco 19
THE DE LAVAL COMPANY, Limited
PETERBOROUGH
QUEBEC MONTREAL WINNIPEG VANCOUVER

DE LAVAL OIL PURIFIERS
FOR DIESEL LUBRICATING OIL

Take a Dart Apart

NOTE HOW THE TWO BRONZE SEATS ARE GROUND TO FORM A TRUE BALL JOINT



Two bronze seats ground to a true ball joint *insure* a drop-tight connection without excessive wrenching. Regardless of length of service, a Dart uncouples easily and without damage—is ready for a new job wherever needed. Body and nut are of high-test air-refined malleable iron—are practically indestructible.

That's why it pays to standardize on Darts. Ask your supplier to send some with your next order.

E. M. DART MFG. CO.
Providence 5, Rhode Island

DART UNIONS

GAS TURBINE POWER PLANT

(Continued from page 88)

which passes through a gas turbine after being heated in the process of burning off the carbon. As a by-product, a modest amount of power can also be delivered by the turbine shaft. It is interesting to note that, in effect, a solid fuel supplies the energy for this early form of the gas turbine. The carbon residue from the cracking process is deposited on small pellets of refractory-like catalyst, and it is this solid fuel which is burned away.

The Velox boiler is somewhat similar to the Houdry application, since the compressor of the gas turbine set acts as a supercharger to supply combustion air to a compact steam generator. The products of combustion, after giving up as much heat as possible to the water and steam, still retain most of the pressure imparted to them in the compressor. By expanding through an efficient turbine, the exhaust gas can supply all of the energy needed by the compressor and have enough left over to generate some useful power.

The first gas turbine intended to produce power alone was installed by Brown-Boveri in a bomb-proof shelter near the city of Neufchatel in Switzerland. Intended as a standby plant for emergency use, this unit had no regenerator, and its maximum turbine inlet temperature, consistent with pre-war metallurgy, was 1025 F. Despite this, tests showed an efficiency of 18 per cent at full load. Figure 10 shows this unit set up for shop tests at Brown-Boveri.

As a locomotive power plant, the oil-fired gas turbine built in 1939 by Brown-Boveri was a pioneer. In this service, ability to produce relatively high efficiency without the use of water is of paramount importance. The successful operation of this first locomotive turbine, shown in Fig. 11, encouraged the Locomotive Development Committee to undertake the task of teaching the gas turbine to burn coal. Successful completion of this program will alter completely the power picture in plants of medium size.

(To be continued)

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[2] The Gas Turbine—An Engineering Possibility Today, by Sanford A. Moss; March 1944.

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[4] The Gas Turbine—Especially as Compared to the Steam Turbine, by F. K. Fischer and C. A. Meyer, 1944.

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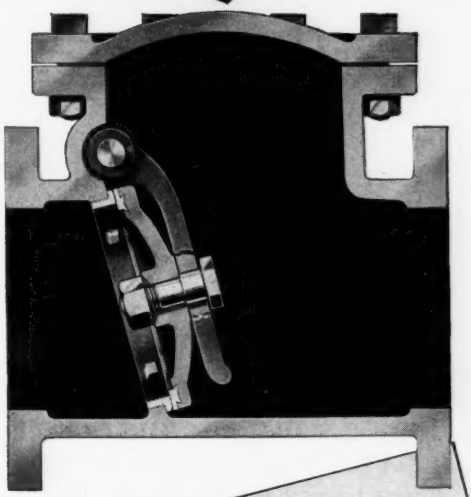
Every feature you want in an

IRON BODY SWING CHECK VALVE

is in this KENNEDY DESIGN

Kennedy Iron Body Swing Check Valves are far more than merely a tee fitted with a swinging disc. The angle of the disc has been carefully determined to assure easy opening at low pressures and to minimize the shock of closing under high pressures. In addition, the disc is designed to revolve and to be self-adjusting, so that it will not stick on the seat, and will be thoroughly reliable and positive in operation.

Bronze mounted valves have bronze seat rings screwed into the body, and all iron valves can be furnished with malleable iron screwed seat rings. Discs may be bronze-faced, leather-faced or all iron. These valves are furnished in a full range of standard sizes in standard and 250-lb. designs and will operate in either horizontal or vertical position. Write for the 240-page Kennedy Catalog describing these valves in detail, together with the extensive Kennedy line of valves and pipe fittings for all standard requirements.



No. 106

Buy From Our Distributor

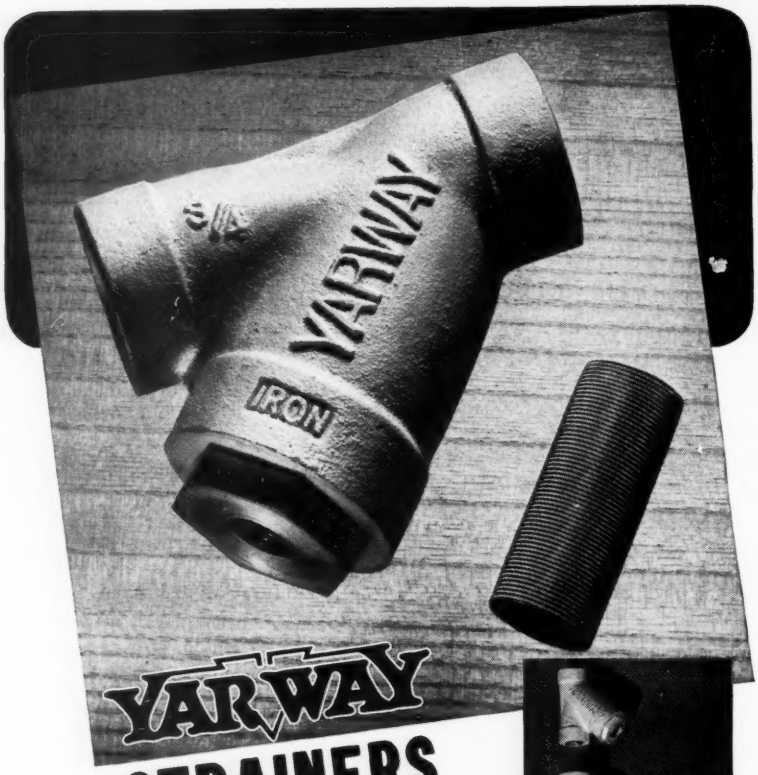
YOU WANT THESE VALVE FEATURES
. . . you'll find them in this KENNEDY design

1. **Generous Strength . . .** Body and bonnet are of high-grade dense metal with ample thickness and rounded fillets. Stem has large diameter and extra large number of contact threads.
2. **Dependable Operation . . .** Discs are self-adjusting, do not stick on the seat, and open or close promptly on change in direction of flow.
3. **Lasting Tightness . . .** Discs and seats seat accurately, and their sturdy design resists distortion and has special provisions for take-up of wear.
4. **Long Life . . .** Many Kennedy valves have been in daily use a quarter century and more.
5. **Convenient Repacking . . .** Glands and packing are easily accessible.
6. **Economical Maintenance . . .** Long wear built into all parts, and adjustments or other attention are seldom required.

THE KENNEDY VALVE MFG. CO.
Elmira, New York

KV-144

KENNEDY *valves - pipe fittings - fire hydrants*



STRAINERS "Police the Pipelines"

YARWAY STRAINERS are *selling by the thousands* because they are better engineered for the service.

"*The Screen is the Thing*"—a high-grade, woven Monel wire screen that stops the dirt, lets fluids flow freely.

Then, too, purchasers like the *body finish—Cadmium plated for protection against corrosion and for better appearance.*

And last but not least, it is "*Easy to Clean*" having a steel blow-off bushing, precision machined with straight thread. Screen and bushing come out together—go back together, automatically aligning.

Six sizes, ½" to 2" for pressures up to 600 lb serve practically all strainer needs.

Sold by over 100 Mill Supply Houses. See your Supply House or write for Bulletin S-201.

YARNALL-WARING COMPANY
114 MERMAID AVENUE PHILADELPHIA 18, PA.

YARWAY STRAINERS

(Continued from page 124)

ELECTRIC INDUSTRY PUBLIC RELATIONS

A COMPREHENSIVE examination of the public relations of the electric light and power industry, stressing basic fundamentals in the approach to industry-wide problems, is being undertaken by the National Association of Electric Companies.

The two themes being developed are the concept of public relations as a basic function of business, and recognition of the industry's public relations position as the aggregate of the public relations of all local operating companies.

More than 125 management representatives of electric companies in the northeastern United States, including both members of NAEC and non-member companies, participated in the first two clinics in Boston and New York. During the next three weeks similar regional meetings will be held at Chicago, Salt Lake City, San Francisco, Ft. Worth and Atlanta.

The NAEC, established last year to act as a public relations organization for the industry, now represents 110 operating electric light and power companies. It is headed by Purcell L. Smith, former president of Middle West Corp.

DAY SPEAKS TO MINING INSTITUTE

MEMBERS OF THE West Virginia Coal Mining Institute learned recently from T. A. Day, special representative of Bituminous Coal Research, Inc., that science and technology are "working overtime" to help the bituminous coal industry "hold its rightful place" in the post-war battle for business from the fuel-buying public.

Mr. Day said that "present-day interest in coal research is intensified by the fact that coal comprises 98.8 per cent of this country's proved reserves of mineral fuels, including natural gas, petroleum and oil shale as well as coal."

The result of this new interest, he added, is that millions of dollars are being spent on research to improve the utilization of bituminous coal and on the technological development of equipment for producing, processing and utilizing the Nation's basic source of energy. BCR, the national research agency of the bituminous coal industry, is geared to increase the tempo of its development activities in 1947, the speaker said, with research on many major projects under way.

Gerald Anthony Paul, R.A. has announced the establishment of quarters for the general practice of architecture, engineering and industrial design, at 333 Fourth Avenue, New York 10, New York.

Obituaries

FRANK M. TRAVIS

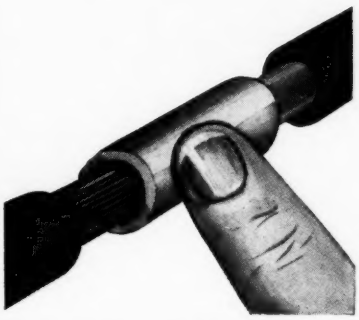
FRANK M. TRAVIS, prominent public utilities official, died recently in Torrington, Conn. He was 79 years of age. At his death he was president of The Torrington Electric Light Co. and chairman of the board of the Torrington Water Co. and the Bridgeport Gas Light Co. He was also a director of the Connecticut Power Co.

Mr. Travis is survived by his wife, Martha Hoerle Travis; two daughters and a grandson.

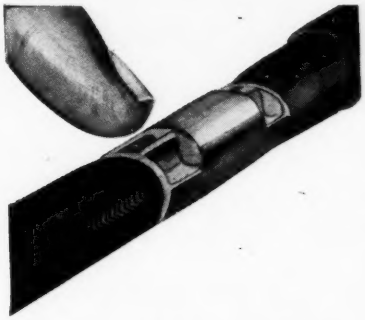
HERBERT W. YOUNG

HERBERT WILLIAM YOUNG, founder and president since 1908 of the Delta Star Electric Co. and formerly an official of General Electric Co. and Westinghouse Electric Corp., died recently in Chicago at the age of 70. Mr. Young was born in Holyoke, Mass.

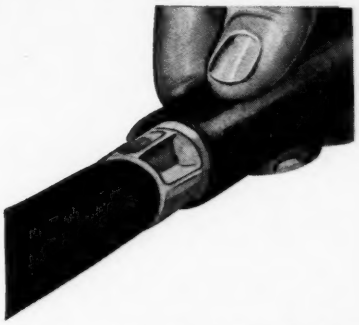
One of his first jobs was with the Whitney Electrical Instrument Co. in Manchester, N.H. In 1898 he joined General Electric Co. at Lynn, Mass., where he was employed in the Instrument Assembly department and the



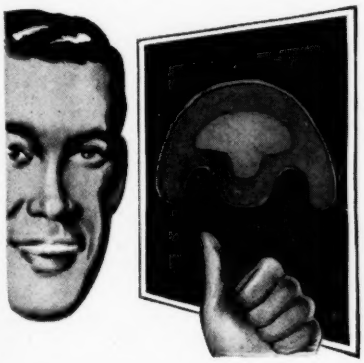
Yes, It's A New Method now used on many of our motors to make winding connections *uniform*, mechanically and electrically. How it works: First, we remove insulating varnish from wire ends by a special process. The bright wire ends are then slipped into this tinned-copper connector. There's no twisting, scraping, unnecessary bending.



Then . . . With A Special Tool, we compress — actually "bond" together — each wire and connector into a homogeneous mass. Every connection is precisely the same as every other . . . no brazing or soldering is used . . . no chance to weaken wires or damage insulation. Wires can't pull out or break-off.



Finally . . . We Slip A Tough, flexible plastic protective tubing over the complete connection. Result: when stator windings are impregnated with insulating varnish and baked out, every connection is uniformly sealed and insulated . . . making a stronger . . . more compact and efficient job . . . another factor demonstrating A-C quality.



Here's An Actual Cross Section microphoto that shows, better than I can tell you, just what happens inside the connection itself. Notice how connector and wires are "bonded" into a single mass. Every connection has precisely the same electrical capacity, assuring balanced phasing.

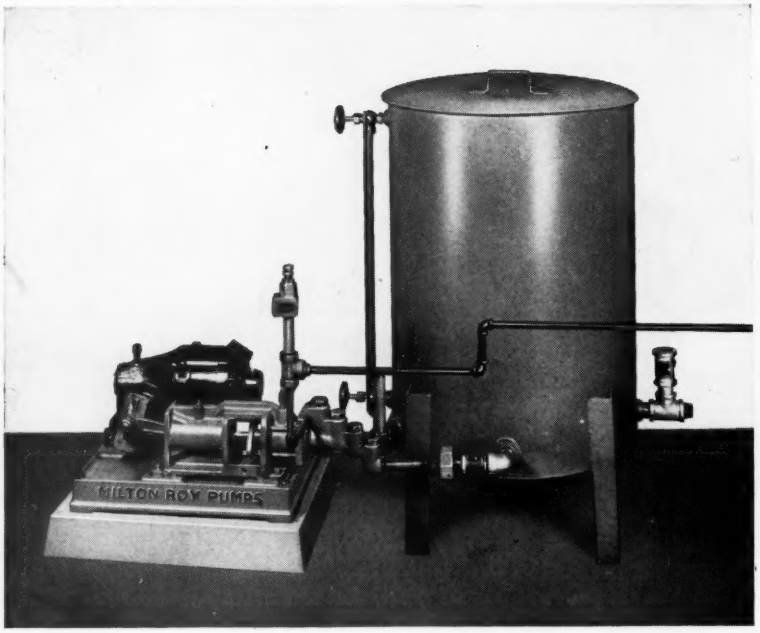
A-C Builds "Quality" Into Motors

YES, PAYING ATTENTION to details like this new, improved connection contributes importantly toward greater reliability, better performance in motors. Next time you want *good* motors, liberally designed, and with an earned reputation for standing up year after year under toughest operating conditions, specify "Allis-Chalmers". For the complete story call your nearby A-C motor dealer or A-C sales office. ALLIS-CHALMERS, MILWAUKEE 1, WIS.

A2147

ALLIS CHALMERS

One of the Big 3 in Electric Power Equipment — Biggest of All in Range of Industrial Products



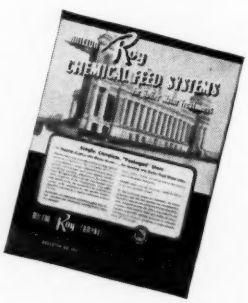
MILTON ROY

CHEMICAL FEED SYSTEMS

for Boiler Water Treatments

Authorities agree two distinct methods are necessary for chemically treating boiler water. Sodium Sulfite should be fed into the suction side of the feed water pump . . . to remove dissolved oxygen, insure against corrosion and prevent pitting. Other treating chemicals, such as phosphates, soda ash and caustics cannot usually be fed in this manner. Individual chemical feed directly into each boiler is the approved method . . . to prevent scale formation, control alkalinity and prevent embrittlement.

Milton Roy "Packaged Units" are available for both treating methods. For internal treating the unit includes heavy gage welded steel tank, gage glass, low level pump cut-out and alarm, together with necessary pump or pumps. For sulfite feed the unit includes 50 gal. 12 gage welded tank, gage glass, low level pump cut-out, bell alarm, doughnut float and one Milton Roy pump with screw adjustment of stroke.



These "Packaged Units" are available also with electronic control, to continuously operate at a speed proportional to the rate of feed water flow as measured by a standard type flow meter. Fully automatic control is thus obtained, treatments are precisely as required, waste of chemicals is avoided.

For complete description of these systems, with specifications, diagrams, selection tables, etc., write for Bulletin 451. If interested in automatic controls, ask also for Bulletin 468.

MILTON Roy COMPANY

1332 E. MERMAID AVE., CHESTNUT HILL, PHILA. 18, PA.

engineering division. From 1905 to 1907 he was connected with the Boston office of Westinghouse. He and an associate formed the Delta Star Electric Co. in Chicago in 1908. Mr. Young is survived by his wife, Harriet.

L. LEWIS COHEN

L. LEWIS COHEN, chairman of the board of the Union Asbestos and Rubber Co., passed away at his home in suburban Highland Park, Ill., October 25th at the age of 55.

Formerly president of the company he founded in 1918, Mr. Cohen became Chairman of the Board in 1941. Previous to the formation of Union Asbestos and Rubber Co., Mr. Cohen was associated with the Union Supply Co. and the Union Pacific and Southern Pacific railroads.

JOHN J. KANE

JOHN J. KANE, 63, general patent attorney for the Allis-Chalmers Mfg. Co., Milwaukee, Wis., died November 8. A patent attorney for Allis-Chalmers since 1912, Mr. Kane became head of the company's patent department in 1944.

Before coming to Allis-Chalmers, Mr. Kane had been in the United States patent office, Washington, D. C., for six years. A native of Worcester, Mass., Mr. Kane graduated as an electrical engineer from the Worcester Polytechnic Institute and received his master's degree in patent law from George Washington University in Washington, D. C.

Mr. Kane was a past president of the Milwaukee Patent Law Association and a member of the American Patent Law Association, the American Bar Association and the Institute of Electrical Engineers.

DR. SANFORD A. MOSS

DR. SANFORD ALEXANDER MOSS, consulting engineer for General Electric Co. in Lynn, Mass., died recently at the age of 74. Dr. Moss received his advanced education at the University of California where he was granted the degree of B.S. in mechanical engineering in 1896. He received his master's degree in 1900 from the U. of C. and Ph.D. from Cornell in 1903.

Dr. Moss is well known for his work on airplane and automobile superchargers and centrifugal compressors. He was the author of numerous papers for technical societies and periodicals.

R. E. POST

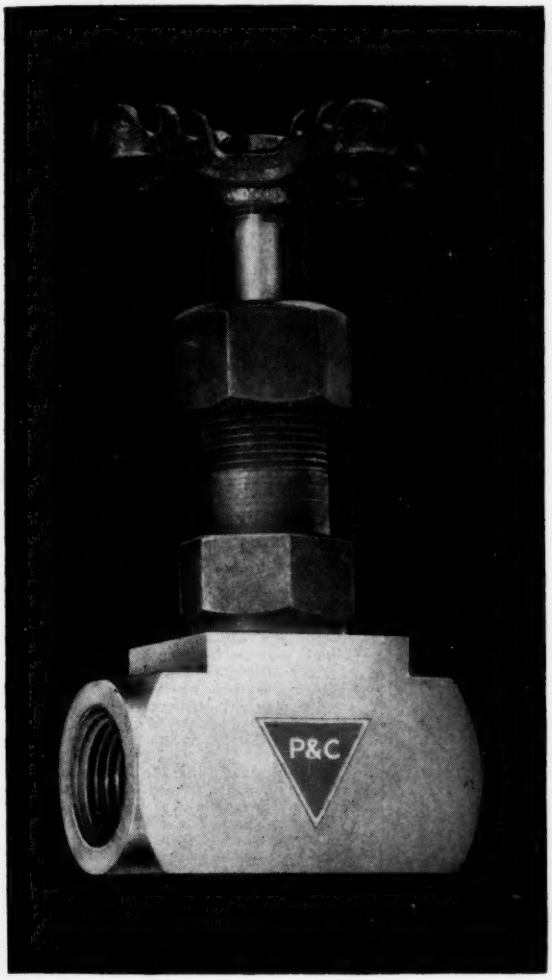
R. E. POST, veteran representative of Fairbanks, Morse & Co., who has, for the past decade, been manager of the firm's Washington, D. C. office passed away after a month's illness in a Washington hospital, Wednesday, November 13.

Mr. Post had a long and illustrious career. Starting with the scale organization, E. and T. Fairbanks and Co., he joined Fairbanks, Morse & Co., when the two organizations were merged in 1923. He was for many years manager of the company's Baltimore Branch. Later he became manager of the Washington, D. C. office which position he filled until his death.

Mr. Post was born January 4, 1877 in

"BAR STOCK" VALVES MAKE LASTING FRIENDS FOR READING-PRATT & CADY

These tough little globe and angle valves are machined from highest quality bar stock—bronze, carbon steel or alloy steel. Working pressures range from 4000 pounds at 150° F. to 475 pounds at 1000° F.



READING, PENNSYLVANIA—When Bar Stock Valves were first developed by R-P & C, they were introduced as close control valves. They are that. But that's only part of the story. Users of valves in large quantity have come to know Bar Stocks as general purpose valves. Whether the application calls for normal regulation, shut-off, or close control, Bar Stocks do a dependable job. And, because of the method by which they are made, they are economical to buy—sound value for the money.

Bar Stocks are typical of READING-PRATT & CADY'S line of high quality products. Consider R-P & C as a single responsible source for bronze, iron and steel gate, globe, angle and check valves—for cocks and Lubrotite gate valves—cast steel fittings.

This leaflet gives highlight facts about Bar Stock Valves. Just ask for DH-1323.

ACCO

Reading-Pratt & Cady Distributors Are Located in Principal Cities

Reading, Pa. • Atlanta • Baltimore • Boston • Chicago • Denver • Detroit • Houston • Los Angeles • New York • Philadelphia • Pittsburgh • Portland, Ore. • San Francisco • Bridgeport, Conn.

TRADE MARK

READING-PRATT & CADY DIVISION
AMERICAN CHAIN & CABLE

The new forged steel CHIKSAN XH Swivel Joint combines the easy turning and effective pack-off — for which all CHIKSAN Joints are noted — with high capacity. Built of forged steel, with flame-hardened races, this new CHIKSAN Joint is designed for heavy duty services of all kinds. It makes possible the fabrication of all-steel lines with perfect flexibility, yet capable of withstanding working pressures to 12,000 psi... with greater safety and longer life. Engineering data on request.

In addition to the new CHIKSAN XH forged steel Swivel Joint, there are over 500 different Types, Styles and Sizes available for pressures from 300 to 3000 psi, and temperatures to 500° F.

REPRESENTATIVES IN PRINCIPAL CITIES

EXPORT REPRESENTATIVE: Chiksan Export Co., Brea, Calif.

Branches: New York 7, Houston 2

CHIKSAN

BALL BEARING SWIVEL JOINTS FOR ALL PURPOSES

CHIKSAN COMPANY
BREA, CALIFORNIA
New York 7 Houston 2

Wilmington, N. C. He was educated in the public schools and high school of Wilmington and the Stevens Preparatory School and Stevens Institute of Technology of Hoboken, New Jersey.

MANUFACTURERS' News

HALL'S FIRST "CO-OP" STUDENT REPORTS

THE FIRST "cooperative" student from the University of Cincinnati to work at Hall Laboratories, Pittsburgh, reported for first assignments a few days ago. He is a Ft. Lauderdale, Fla. boy—Samuel R. Osborne, 24, who has just completed three years in army ordnance.

The University of Cincinnati pioneered the idea of putting students at work in industry for half of the five-year college course. Under this system two students are assigned to a single job, each staying on the job two months and spending the next two months in the classroom on the campus. Mr. Osborne begins by learning how trained technicians analyze water samples as they come in from hundreds of industrial plants.

NEW POWER PLANT FOR ROEBLING

THE RUST ENGINEERING CO. of Pittsburgh, Pa., has announced they have been awarded a contract to design and construct a new power plant, costing in excess of $1,000,000, for John A. Roebling's Sons Co., at Roebling, N.J.

The contract calls for the installation of three 80,000 lb per hour high pressure boilers with auxiliary equipment and one 4,000 kw turbo-generator. The generator will be an addition to the present capacity, but the boilers will replace older boilers, which will be retained as reserve units.

The generator will be installed in an existing building. A new building may be constructed to house the boilers. The installation now is being designed and construction will start in the spring of 1947.

STONE AND WEBSTER'S CHAIRMAN RETIRES

THE RETIREMENT of Edwin S. Webster as chairman of the board of Stone & Webster, Inc., was announced recently at a meeting of the board of directors. Mr. Webster, a co-founder of the firm, will continue his directorships in the company and its subsidiaries, however and will maintain his office in the Stone & Webster Building in Boston where he will be available for consultation. He is succeeded as chairman by William T. Crawford who for the last ten years has served as executive vice present. Whitney Stone, son of the late Charles A Stone, will continue as president.

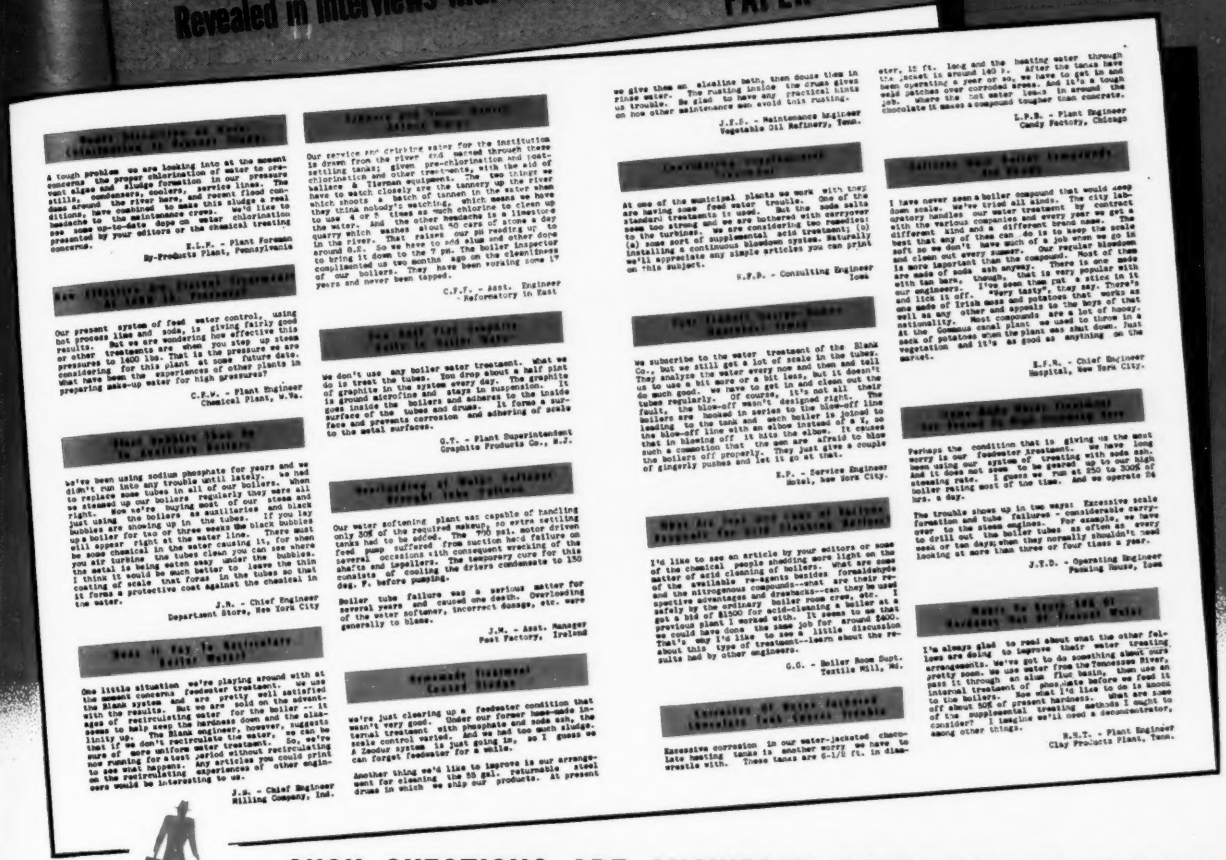
Together with Charles A. Stone who died in 1941, Mr. Webster formed in 1889 the partnership which later was to be known as Stone & Webster, Inc. The two had been close friends and classmates at Massachusetts Institute of Technology from which they were graduated in 1888 with the degree of S.B. from the Department of Electrical Engineering. The firm they formed was the first organization in the country to operate exclusively as engineering consultants.

RILEY STOKER REOPENS PITTSBURGH OFFICE

THE RILEY STOKER CORP. has announced the re-establishment of a direct sales engineering office in the Pittsburgh territory. The new Riley office will be located in the Park Building, Pittsburgh, Pa. and will be in charge of Charles S. Allen, Jr.

Mr. Allen has been associated with the Riley Stoker Corp. in a sales engineering capacity for over six years and is thoroughly qualified to handle sales engineering problems involving fuel burning and steam generating equipment. Previous to joining the Riley

Among the Problems on WATER TREATMENT
Revealed in interviews with readers of a *Power Plant* PAPER



. . . SUCH QUESTIONS ARE ANSWERED EVERY DAY BY DEARBORN

BUT ANSWERS are not enough . . . The problems are actually solved

Back of the Dearborn Engineer is 50 years of experience in solving water problems.

In arriving at these correct answers, Dearborn laboratory experts and service engineers collaborate. Analyses and reports on plant conditions go from the field engineer to the laboratory. Then the answers come up . . . special chemical treatment formulations, adjustments, installation of proper feeding equipment, innumerable suggestions to eliminate your boiler water difficulties.

Problems incident to proper steam production are solved permanently. Get in touch with the Dearborn Engineer in your vicinity or write to us direct.

Dearborn
TRADE MARK REGISTERED

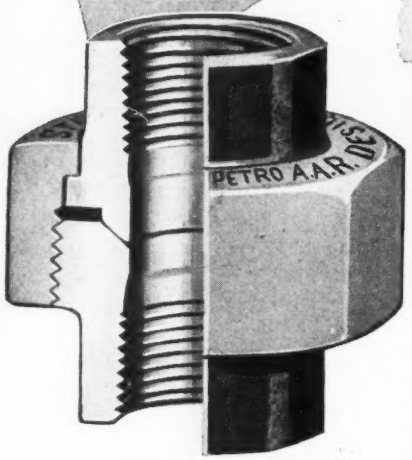
"THE LEADER FOR OVER HALF A CENTURY"
ENGINEERING SERVICE AND WATER TREATMENT

Dearborn Chemical Company
Dept. F, 310 S. Michigan Ave., Chicago 4, Illinois

there is

ENDURANCE

in FORGED STEEL UNIONS



SIZES ⅛" TO 3"

Petro

AMERICA'S MOST UNIVERSALLY USED UNION

PETRO unions have integral steel to steel seats. Made to A. A. R. design. 600 lbs. S.W.P.-2000 lbs. C.W.P. Extra heavy ends and nut with nut threads that are permanently lubricated. The seats are machined and cold rolled.

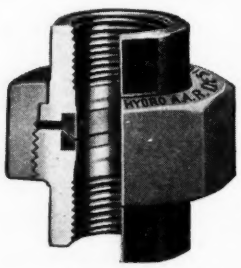
A PARTIAL LIST OF PROVEN SERVICES

Pressures from a vacuum to 3000 lbs.: Temperatures from 100° below zero F. to 1000° above zero F.: On Steam, Gas, Air, Oil, Gasoline, Ammonia, Chemicals, and any service in which Steel or Wrought Iron Pipe is Used.

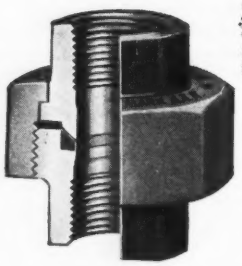
Hydro

THE ONLY FORGED STEEL UNION WITH TWO BRONZE SEATS

Made to A. A. R. design. 600 lbs. S.W.P.-2000 lbs. C. W. P. HYDRO unions have extra heavy ends and nut, with the nut threads permanently lubricated. The bronze seats are completely fused to the steel and are then machined and cold rolled.



SIZES ¼" TO 3"



SIZES ¼" TO 3"

Mark A.A.R.

AMERICA'S FIRST STEEL UNION

The MARK A. A. R. unions have bronze to steel seats. Made to A. A. R. specifications. 600 lbs. S. W. P.-2000 lbs. C. W. P. MARK A. A. R. unions have extra heavy ends and nut with the nut threads permanently lubricated. The bronze seat is completely fused to the steel and then machined and cold rolled.

WRITE FOR PAMPHLET AM-67 • ORDER BY TRADE NAME FROM YOUR JOBBER

ORIGINATORS AND PIONEERS OF FORGED STEEL UNIONS

CLAYTON MARK & COMPANY

1900 DEMPSTER STREET • EVANSTON, ILLINOIS

Stoker Corp., Mr. Allen had extensive experience in the oil burning field.

ONE MORE PROOF WE LIVE IN A "BE-KIND-TO-SUPPLIERS" AGE

IN HIS BATTLE for materials, every manufacturer well knows that he has been living in a "Be-Nice-To-Salesmen" and "Be-Kind-To-Suppliers" Age. Latest evidence to come our way is a two-color four-page folder being handed out to all callers by the Union Chain and Manufacturing Co. of Sandusky, Ohio.

The front page says, "Union Chain Welcomes You Cordially—" and then there is a blank space the size and shape of a business card where the receptionist writes in "Mr. Smith" or whatever the visitor's name happens to be. A neat trick.

The two inside pages offer variety of services and cordialities but the back page comes up with another insidious touch designed to make the caller put the folder in his pocket to show it around. On the back page is a map of Sandusky and area, showing locations of automobile routes, railroad and bus stations, hotels, restaurants and important plants.

ROCKWELL ACQUIRES OHMER CORPORATION

PURCHASE OF the Ohmer Corp., Dayton, Ohio, by the Rockwell Manufacturing Co., Pittsburgh, has just been announced by Colonel Willard F. Rockwell, Board Chairman and President.

J Allen Harlan, who has served as President of the Dayton concern for the past year will remain with the new ownership as Vice President. The Company will continue to operate as the Ohmer Corp., a wholly-owned subsidiary of Rockwell Manufacturing Co., and maintain plant and headquarters in Dayton.

G.E. BUYS STEEL MILL

THE MAHONING VALLEY STEEL CO., Niles, Ohio, a hand steel mill for the manufacture of hot-rolled sheets, has been purchased by the General Electric Co., it was announced recently.

John P. Hosack, who has been vice president and treasurer of the steel company, has been named president and treasurer of the new G.E. affiliate. The company was established in 1916 and was owned principally by the W. Aubrey Thomas family of Niles. Other officers who will continue in the same capacity are George L. Wick, secretary, and Thomas C. Clingan, assistant treasurer.

SIMON MANAGES C-H PHILADELPHIA PLANT

CUTLER-HAMMER, INC., Milwaukee, announces the appointment of J. P. Simon as Manager of its Philadelphia District Office. In this position, Mr. Simon will have direct charge of all sales in the Philadelphia territory and will have supervision of the company's branch offices in Baltimore, Md., Washington, D.C., and York, Pa.

Mr. Simon is a graduate of New York University and received the degree of Electrical Engineer from that school in 1928. His experience with the Cutler-Hammer organization began while he was still in school when he spent three summers working in the Cutler-Hammer New York factory.

BAILEY RECEIVES FRENCH ORDER

BAILEY METER CO., Cleveland, has received a large order for steam plant control from the Union d'Electricite of Paris, France for their Gennevilliers Power Plant according to a recent announcement. This order provides for complete metering equipment and coordinated controls for combustion, feed water and superheated steam temperature to be installed on six boilers. Each boiler has a maximum capacity of 530,000 lb of steam per hour at 1325 psig and 980 F

GREENE, TWEED VACATES N.Y. WORKS

GREENE, TWEED & CO., manufacturers of Palmetto packings and other products in the field, now producing in two separate plants has vacated its New York works, according

DOUBLE your safety on boiler blow-off...

...with this EVERLASTING team!

As an engineer, you want sure, *doubly-safe* boiler blow-off action. Well, here it is!

This EVERLASTING Duplex Unit consists of two valves . . . a lever-operated "straight-through" type valve (on left) and a wheel-operated angle-type valve.

The "straight-through" type opens with about a quarter-turn of the lever, giving you wide-open, full-pipeline flow. And you can forget the worry of corrosive and abrasive action, for this valve is so designed that no damaging grit can lodge between the seat and the sealing disc. The rotating, self-lapping action of the sealing disc against the seat—as the disc moves across or away from the port—provides a *more lasting seal* than you'll find in any ordinary valve. In fact, the more the valve is used, the more this rotating, self-lapping action *improves the drop-tight seal!*

The angle-type valve is stoutly built to withstand the blow-off shock. It takes the punishment, all right . . . *and endures!* Abrasive solids cannot work their costly damage in this valve either — there are no pockets where abrasives can lodge. You get long-time, low-maintenance service!

Maintenance cost of these EVERLASTING Valves is practically nothing. And remember, it's a team that *doubles* your safety factor.

Conforming to A.S.M.E. and other codes for boiler blow-off service, EVERLASTING Valves are made in sizes 1½", 2" and 2½", for pressures up to 600-lbs. Either valve is available separately, in cast iron, or cast steel.

You can have complete information without obligation. *Just drop us a postcard — today!*

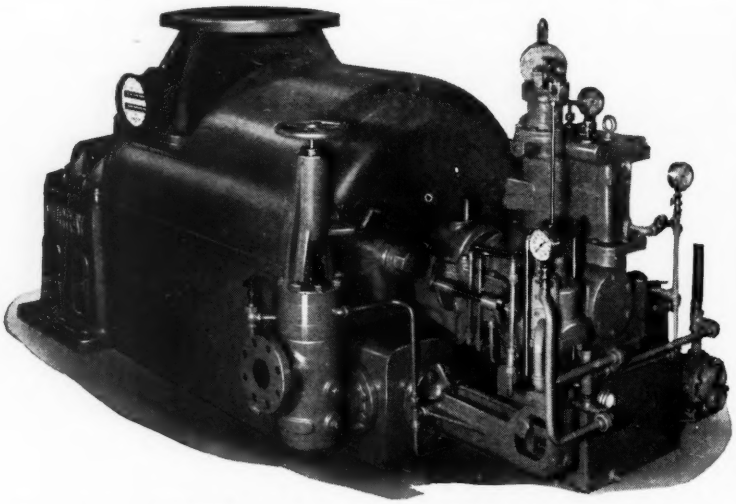
Left view shows the EVERLASTING "straight-through," rack-and-pinion type — the SEALING valve.

Right view shows the EVERLASTING angle-type — the BLOWING Valve.

EVERLASTING VALVE COMPANY
49 Fisk Street, Jersey City 5, N. J.

EV-319

Everlasting Valves GIVE EVERLASTING SERVICE.



One of two MURRAY multistage steam turbines, designed to deliver 685 horsepower on steam at 110 pounds and exhausting to 26½ inches Hg vacuum, furnished to drive high speed centrifugal compressors for refrigeration in one of the most prominent Southern Hotels. A third unit has recently been shipped. Equipment includes variable speed oil relay governor, trip and throttle valve, strainer surrounding the double seated balanced governor valve, and force feed lubrication.

MURRAY
MULTISTAGE
STEAM TURBINES

★ ★ ★ ★

The complete MURRAY line of steam turbines includes all variations of mechanical drives, and turbine generator sets up to and including 3000 KW rating.

Sales Representatives for Murray products are located in all principal cities.

MURRAY IRON WORKS COMPANY

BURLINGTON, IOWA

Builders of Steam Power Equipment for Three Quarters of a Century

to a recent announcement. In an effort to provide greater efficiency and services for the benefit of users and distributors of its products the company will incorporate all its facilities under one supervision in its North Wales, Pa. plant.

The company announced that this move also was part of an aggressive program of expansion which includes several new products which are kindred to those now being produced by the Company.

PERSONNEL CHANGES AT I-T-E

I-T-E Circuit Breaker Co. has announced two major changes in personnel. Harry L. Buck, Assistant General Manager in charge of Special Products Division, has been elected Treasurer and J. F. Getz, until recently Manager of Switchgear Sales, has been appointed Assistant to the President. Both men are AIEE Associates.

ROTAMETER CHANGED TO FLOWRATOR

Fischer & Porter Co. has announced a change in the name of its variable area type flow rate instruments from "Rotameters" to "Flowrators." The change is occasioned by the argument regarding the root meaning of the word "Rotameter," which is said by some to suggest an instrument for measuring rotation and also because of the controversial pronunciation of the word.

J. H. Hillman has been promoted from chief estimator and application engineer to assistant manager of the sales and engineering departments at the Norwood, O., works of the Allis-Chalmers Mfg. Co., according to a recent announcement. Announced as successor to Mr. Hillman is E. G. Brooker, who became associated with Allis-Chalmers in 1926 from Tri-State University. Also holder of an electrical engineering degree, Brooker was estimator at Norwood before assuming his new post.

Hall Laboratories recently announced the transfer of J. Mylan Harvey from its Pittsburgh to its Cleveland field service staff. Mr. Harcey, as a service engineer, since 1939, has handled water conditioning under Hall system for Pittsburgh district steel plants, as well as the Koppers synthetic rubber plant at Kobuta, Pa. Working with the C. H. Tate Co., Hagan representatives he will continue the same work with steel, rubber, paper, chemical, match and textile industries of the Cleveland area. Murray C. Scott, of the Pittsburgh service engineering staff of Hall Laboratories, will soon be assigned to the West Virginia office at Huntington, aiding J. T. Waldron, who has been handling sales and service in that territory for two years.

Howard Hansen has been named supervisor of the office of J. L. Singleton, manager of district offices of the Allis-Chalmers Mfg. Co., Milwaukee, Wis. Mr. Hansen, who attended the University of Wisconsin, joined Allis-Chalmers in 1941. Since that time he has worked in the company's works accounting department, blower and compressor department and in the administrative office of William C. Johnson, vice-president of the firm's general machinery division.

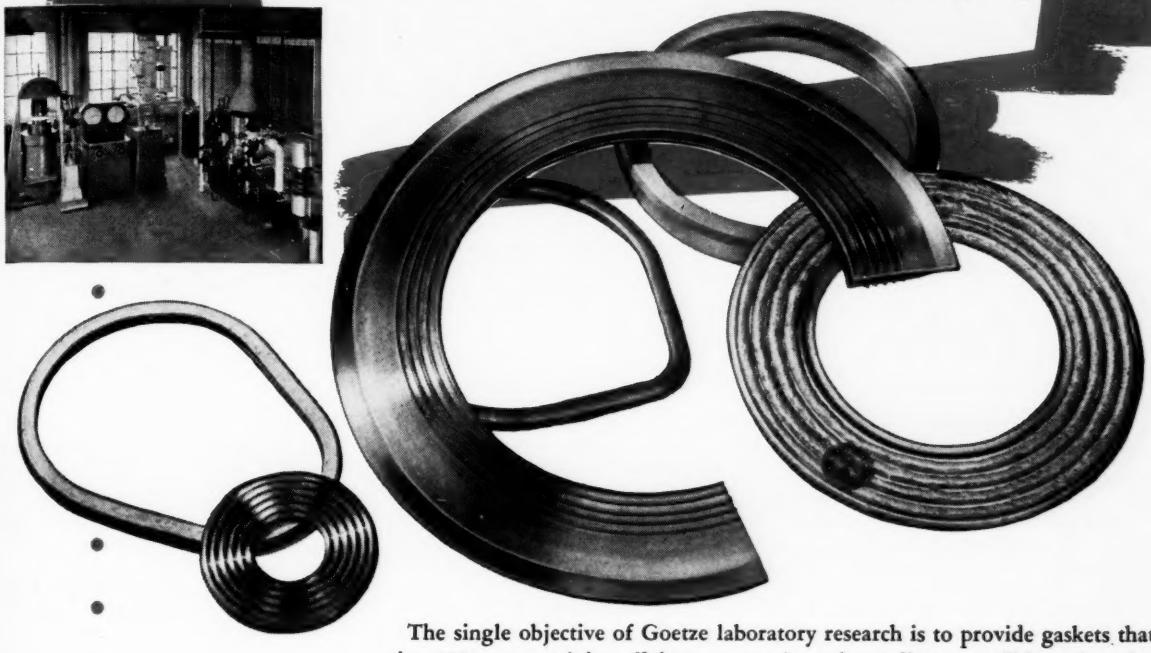
MANUFACTURERS' *Personals*

LARKIN MANAGES HAGAN'S CINCINNATI OFFICE

Effective November 1, George H. Larkin, Washington representative of Hagan Corp. took over management of the firm's Cincinnati office, succeeding L. I. Snodgrass, who represented the company there for more than 20 years.

Mr. Larkin represented the company in Washington through the war years, notably in

100% Joint Efficiency
—the result of RESEARCH



The single objective of Goetze laboratory research is to provide gaskets that give 100 per cent joint efficiency not only under ordinary conditions, but also unusual conditions of temperature, pressure, corrosion or any other factor.

The results of this research have been the development of the only *complete* line of metal gaskets — a line that makes it possible for Goetze to supply the right gasket for your particular applications.

And this research has proved something else: Most gasket troubles aren't necessary. Let a Goetze representative help you review your gasket usage. The chances are that the troubles you take for granted can be eliminated.

We invite your inquiries. What are your problems?

TECHNICAL BULLETINS

Ask to have your name added to the list of engineers receiving "The Gasket"—a series of technical bulletins containing original and useful gasket information from the Goetze Research Laboratory. Write on your company letterhead giving your position.

GOETZE GASKET & PACKING COMPANY, Inc.

17 ALLEN AVENUE, NEW BRUNSWICK, NEW JERSEY

Boston	Cleveland	New Orleans	Pittsburgh	Chicago
Cincinnati	San Francisco	Toronto	St. Louis	Buffalo
Houston	Philadelphia	Detroit	Syracuse	Denver
New York		Los Angeles		Montreal

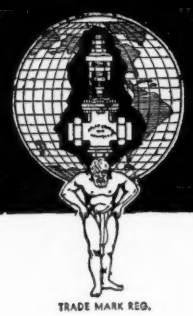
Goetze for GASKETS

"America's Oldest and Largest Industrial Gasket Manufacturer"

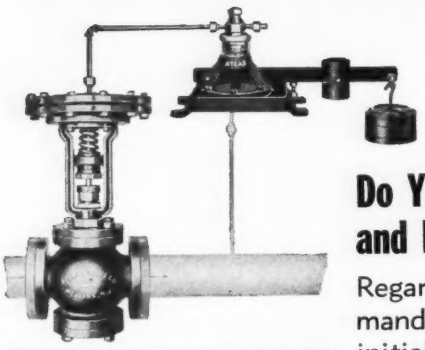
ATLAS

Super-Sensitive

PRESSURE REGULATORS



TRADE MARK REG.



Write for Bulletin No. 1B. It Gives Complete Details.

Do Your Pressures and Loads Fluctuate?

Regardless of fluctuations in demand — Regardless of varying initial pressures — this ATLAS Super-Sensitive Pressure Regulator maintains controlled pressures without variation.

Where pressures must be maintained within fractions of one pound and without perceptible variation even where demands vary widely and initial pressures fluctuate violently—use this ATLAS Super-Sensitive Regulator. Its performance will please you. It is suitable for steam, air, gas, etc., where it is essential to maintain a constant reduced pressure in heating mains, vats, cookers, retorts, etc. It may also be applied as an altitude regulator to maintain constant level in open tanks, or as a pump governor to assure constant pump discharge pressure.

There is practically no limit to the range of applications of this remarkable ATLAS regulator. It will accurately regulate at any pressure between the initial pressure and atmosphere in one stage, operating control valves from ½" to 6".

Specify No. 801—for reduced pressures 2 to 15 lb.
" No. 801-8—for reduced pressures 0 to 5 lb.
" No. 802—for reduced pressures 15 to 150 lb.
Sizes ½", ¾", 1", 1¼", 1½", 2", 2½", 3", 4", 5", 6".

ON WHICH ATLAS PRODUCTS DO YOU WANT INFORMATION?

Check the items below on which you want complete information and mail to us with your name, firm name and address.

- ☐ Super-sensitive Pressure Regulators
- ☐ Other Pressure Regulators
- ☐ Damper Regulators
- ☐ Temperature Regulators
- ☐ Reducing Valves
- ☐ Exhaust Control Systems
- ☐ Pump Governors
- ☐ Float Valves
- ☐ Oil Control Cocks
- ☐ Humidity Controllers
- ☐ CAMPBELL Boiler Feed Water Regulators
- ☐ Thermostats
- ☐ Balanced Valves
- ☐ Control Valves

ATLAS VALVE COMPANY

REGULATING VALVES FOR EVERY SERVICE

Specialists in Regulation for Nearly Half a Century

291 South St., Newark 5, N.J.

Representatives in Principal Cities

relations with the War Department, Navy Department, Coast Guard, U. S. Maritime Commission and foreign governments. He will continue to handle Hagan combustion control, Hall Laboratories water conditioning for steam boilers, and all industrial uses of Calgon, including threshold treatment.

The Hagan Cincinnati staff will remain the same—Charles A. Mitchell, William J. Kienath, J. H. Covode and G. Howard Smith.

D. G. Kimball has been appointed engineer of the General Electric Co.'s Wiring Device and Accessory Equipment Division, it has just been announced. Mr. Kimball's first position, when he joined the Company in 1930, was in the drafting section of the Wiring Device Division.

Dr. W. A. Johnson, manager of the metallurgical section of the Westinghouse Research Laboratories, has been selected to set up and direct a new metallurgical division of the Clinton laboratories at Oak Ridge, Tenn., in connection with military and peacetime applications of atomic energy.

A graduate of Washington, D.C. high school, Dr. Johnson received his bachelor of science degree in metallurgy from Lehigh University in 1935 and a doctor of science degree from Carnegie Tech in 1940. He came to Westinghouse in 1939 as a research fellow and, after being awarded the doctor's degree, taught at Carnegie Tech for one year. He returned to Westinghouse in 1941 and was assigned to the Research Laboratories.

Arthur E. Jacobs has been appointed vice president and sales manager of Blackmer Pump Co., Grand Rapids, Mich., according to a recent announcement. Mr. Jacobs was formerly general sales manager of the Pump Division of George D. Roper Corp., Rockford, Ill., and has, for more than 30 years, been engaged in the design, production and marketing of industrial equipment.

Pell W. Foster, Jr., vice-president and director of the Foster Wheeler Corp., has been appointed vice-president in charge of production. He has been associated with the company for 27 years, was elected a vice-president in 1942 and a member of the board of directors in 1938.

Appointment of Robert O. Bullard, Edward L. Hubbard and John A. Beals to important administrative positions in the Metallurgy Division of the General Electric Chemical Department were announced recently. Simultaneously, the Company announced transfer of responsibility for the manufacturing and engineering operations of permanent magnets and other metallurgical products to the Chemical Department.

BOOK REVIEWS

(Continued from page 129)

as Angular Measurement, Assay Ton, Bags, Bale, Barrel, Board Foot, Bottle, British Thermal Unit, Bushel, Calorie, Carat, Gages, Numbers, Sizes, etc., Hand, Horsepower, Household Measures, Jigger, Knot, League, Pennyweight, Pipe Threads, Quire, Screw Threads, Wearing Apparel, Wire Gages, etc.

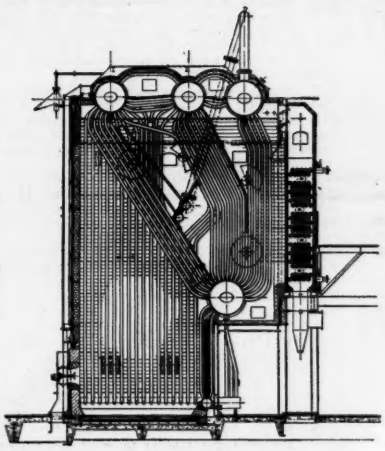
Each of the terms dealt with is described very carefully and many of the terms are described in dimensional figures that should be extremely helpful to those wishing to make use of these terms.

• • •

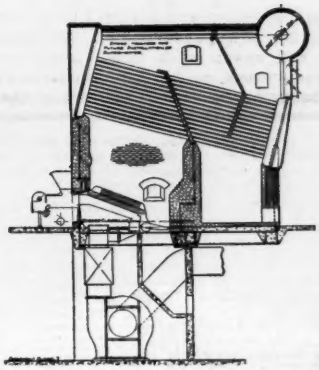
Power Line Carrier Equipment, 40 pages, 8½ by 11 in., illustrated paper bound, Westinghouse Electric Corp., 306 Fourth Ave., Box 868, Pittsburgh 30, Pa. Price $1.00.

This new data book on power line carrier equipment was prepared to assist in the application and use of power line carrier equipment for relaying, telemetering, suervisory control, load control, remote tripping and emergency communication in power systems.

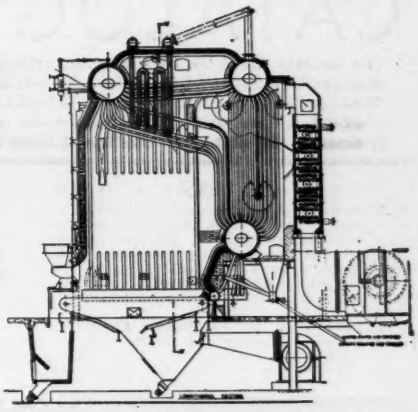
Problems encountered in applying carriers to power lines are dealt with in the application section of the book, and description and operation of individual power line carrier units are given in the section covering equipment. Tables, schematic diagrams, and curves are used to explain how carriers can increase power system efficiency and flexibility.



4 Drum Water Tube Boiler

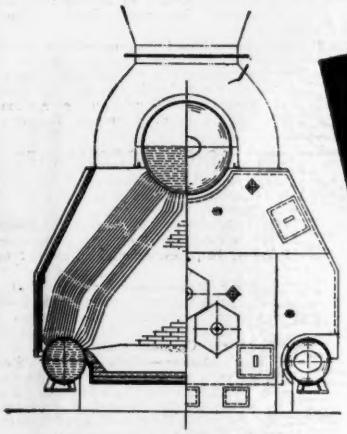


Horizontal Cross or Long Drum Water Tube Boiler

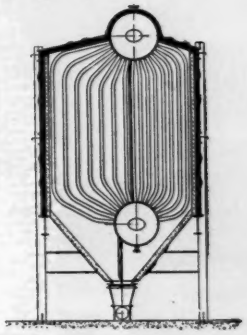


3 Drum "B" Type Water Tube Boiler

WICKES BOILERS

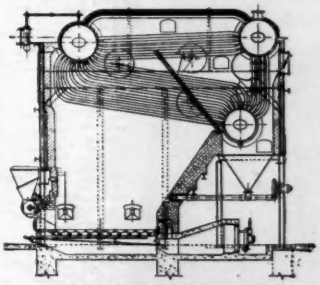


"A" Type Water Tube Boiler for Marine Use

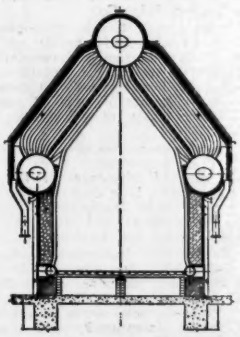


Wickes 2 Drum Waste Heat Installation

Boilers and pressure vessels designed and manufactured in our plant are converting steam loads into industrial energy in scores of important installations the world over. We have the engineers, manufacturing facilities, and skilled workmen to fill your requirements for boilers of any type up to 250,000 lbs. steam per hour and 850 psi. We also perform all types of heavy welded plate fabrication for oil, chemical, paper, and other industrial use. Send us your problems for expert consultation and recommendation. No obligation, of course.



3 Drum Low Head Water Tube Boiler

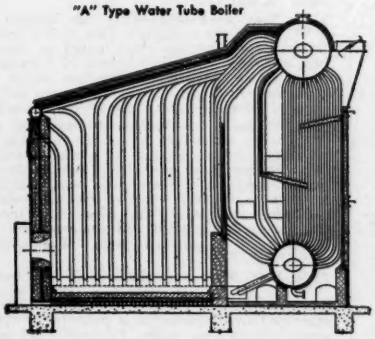


"A" Type Water Tube Boiler

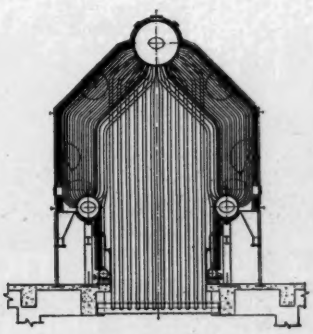
THE WICKES BOILER COMPANY

SAGINAW, MICHIGAN

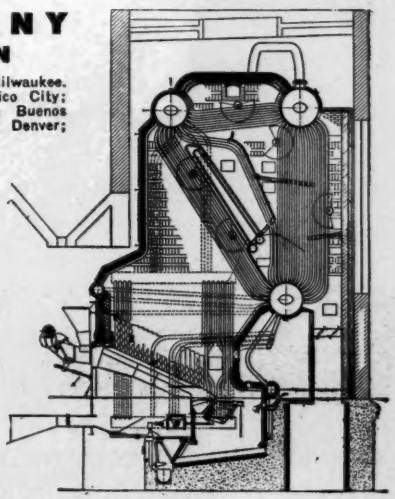
SALES OFFICES: Detroit; Chicago; New York; Milwaukee. Pittsburgh; San Jose; Tulsa; Fort Worth; Mexico City; Saginaw; Boston; Indianapolis; San Francisco; Buenos Aires; Seattle; Los Angeles; Atlanta; Charlotte; Denver; Jacksonville.



2 Drum Water Tube Boiler



Crown "A" Type Water Tube Boiler



3 Drum Water Tube Boiler

CATALOG LIBRARY

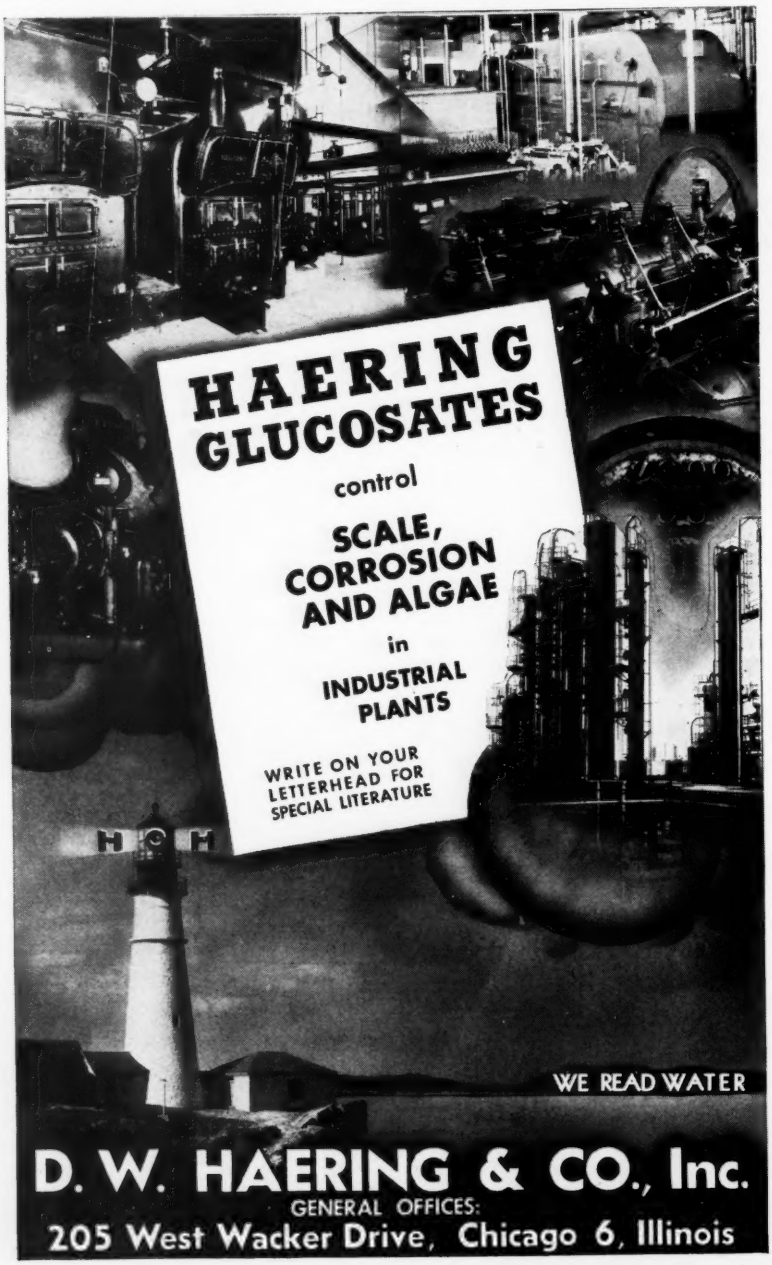
This monthly list of the latest standard catalogs and bulletins is designed to aid the engineer in maintaining his permanent catalog file of engineering data. The items listed, unlike those under Helpful Bulletins, will appear each month except for additions and deletions dictated by space requirement or by the manufacturers issuing the bulletins. Use the Helpful Bulletins coupon in requesting these copies.

BOILERS

51 **Steam Generators**—Catalog almost completely devoted to cross-sectional drawings with accompanying listing of principal data of typical installations in rubber companies, steel works, sugar refineries, municipal plants, etc. Details of furnace water wall construction on inside back cover; 16 pages. Henry Vogt Machine Co., Inc.

52 **Double-Pass Boilers**—Bulletin RM-1 (6th edition); illustrates and describes this line of riveted or welded double-pass steel firebox boilers. Three full pages of dimensions, ratings and other details including dimensioned line diagrams; 8 pages. The Brownell Co.

53 **Boilers, Burners, Accessories**—Bulletin GC-10; condensed catalog of regular products for stationary power plants. Each class of equipment summarized and illustrated. Well illustrated with line drawings and photographs. Illustrations accompanied by brief descriptions; 12 pages. Combustion Engineering Co., Inc.



54 **Standardized Boilers**—Bulletin 746; 4 page bulletin presenting construction and operation information and ordering specifications for this company's Type M boilers. Bulletin illustrated, presents table of measurement and data. Springfield Boiler Co.

55 **Steam Generator**—Bulletin 119; company's Type S steam generator described and features of construction are pointed out. Folder well illustrated and dimensioned drawing and table of dimensions and sizes given. Union Iron Works.

PRIME MOVERS

56 **Wheel Turbines**—Explanation of 14 advantages; diagrammatic illustrations and explanations of operation; 8 pages. Terry Steam Turbine Co.

57 **Axial Flow Impulse Turbine**—Bulletin S-107; six types described; data for estimates; applications; types, casings; wheels and blades; shafts, nozzles and bearings; overspeed stop and other governor features; lubrication; 8 pages. Terry Steam Turbine Co.

58 **Multi-Stage Turbine**—Bulletin SR-114; Casing, lagging, wheels and blades; shafts, nozzles, bearings; governors; speed changer or synchronizer; governor valve and steam strainer; lubrication; general; 10 pages. The Terry Steam Turbine Co.

59 **Steam Engines**—Bulletin No. 306; Engineering data; tabular material, descriptions; 8 pages. Troy Engine & Machine Co.

60 **Generating Sets**—Bulletin No. 108; General descriptions, typical installations, engineering data tables, details of construction, completely illustrated; 24 pages. Troy Engine & Machine Co.

61 **Stationary Diesel Engines**—Dependability, adaptability of Diesel power described and the first five applications pointed out. Its economical and simple design is stressed. Advantages of company's equipment brought out; exceptionally well illustrated; 24 pages. Enterprise Engine and Foundry Co.

AUXILIARIES, ACCESSORIES

62 **Strainers and Separators**—Bulletin 46-50; describes complete line of company's strainers and separators. Dimensions and price lists, dimensioned drawings and photographs; tables of sizes and complete description of applications, operation and design; 16 pages. American District Steam Co.

63 **Atomizing Deaerators**—Bulletin 4160; 3 color drawing illustrates description of principle of operation. Advantages of deaerators are described and illustrated; marine deaerators also covered; 20 pages. Cochrane Corp.

64 **Steam Condensers**—Bulletin 1461 "Steam Condensers"; exceptionally well illustrated with line drawings, charts and photographs. Large proportion of the catalog devoted to engineering information such as calculations of required surface, atmospheric relief valve sizes, tube characteristics, free dry air leakage, pressure-temperature conversion tables and tables of logarithms; 46 pages. C. H. Wheeler Mfg. Co.

65 **Condensate Return System**—Description of operation and possible savings accompanied by line diagram and description of how "Jet-Loop" works; typical installations pictured and described. Drawings and text show proven results from experience of users. 2 page spread of drawings and table of dimensions; 16 pages. Cochrane Corp.

66 **Low Pressure Evaporators**—Description of L. P. evaporators; types of evaporator plants, listing of advantages of L.P. submerged tube evaporators. Line diagrams illustrate principles brought out in descriptions. Typical installations are considered and analyzed; 12 pages. Condenser Service and Engineering Co., Inc.

67 **Power and Industrial Equipment**—Bulletin Q-12; describes and illustrates company's equipment for power and industrial use—steam turbines, motors, generators, feedwater heaters, turbo-chargers, steam jet ejectors, centrifugal blowers. Exceptionally well illustrated; 20 pages. Elliott Co.

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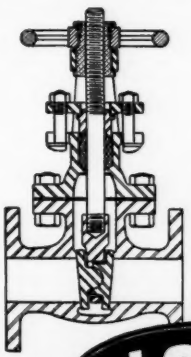

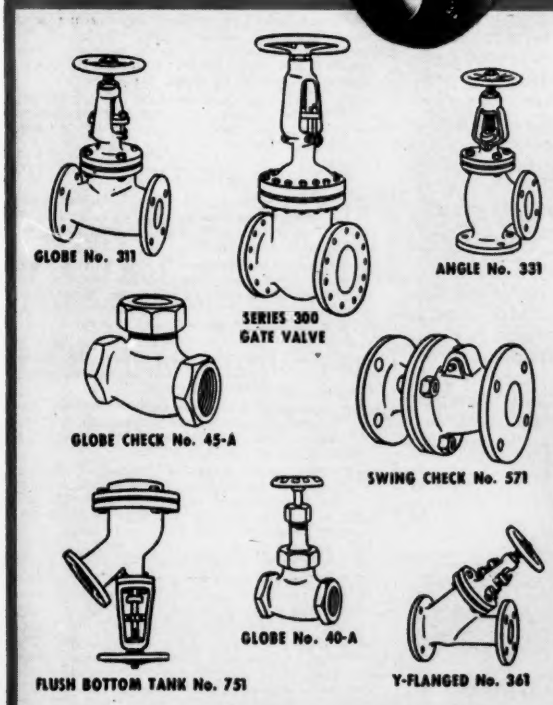

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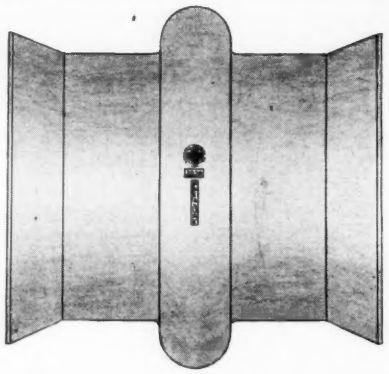

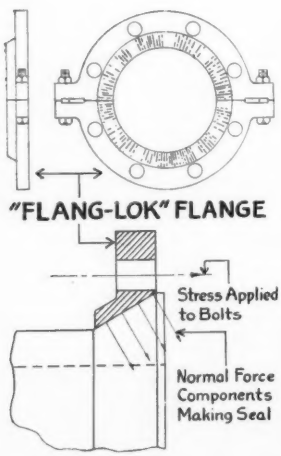

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Fig. 1793—125-pound Iron Body Bronze Mounted Gate Valve. Has flanged ends, outside screw rising stem, bolted flanged yoke, bronze seat rings and taper wedge solid disc. Also available in All Iron.

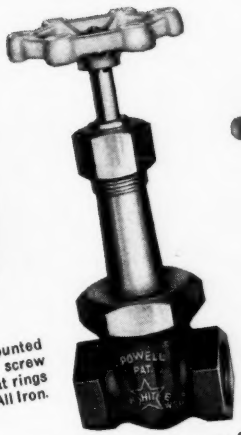

Fig. 375—200-pound Bronze Gate Valve with screwed ends, inside screw rising stem, union bonnet and renewable, wear-resisting "Powellium" nickel bronze disc.

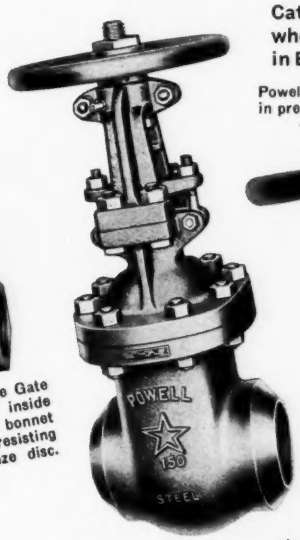

Fig. 1503 W. E.—Class 150-pound Cast Steel Gate Valve with welding ends, outside screw rising stem, bolted flanged yoke and taper wedge solid disc.

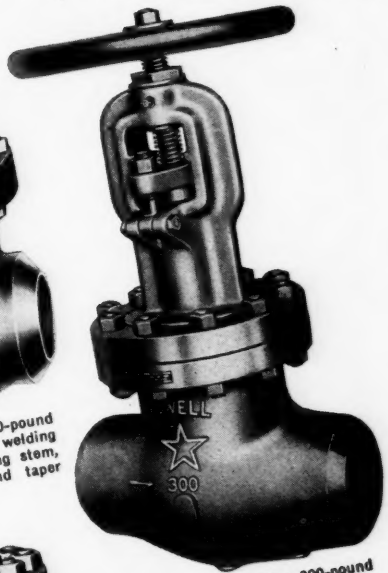

Fig. 3031 W. E.—Class 300-pound Cast Steel Globe Valve. Welding ends, bolted flanged bonnet, outside screw rising stem.

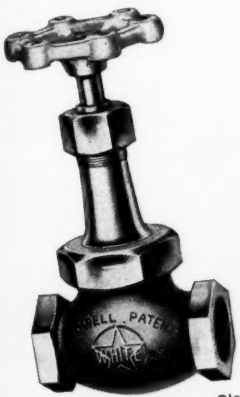

Fig. 1708—200-pound Bronze Globe Valve. Has screwed ends, union bonnet, renewable, specially heat-treated stainless steel seat and regrindable, renewable, wear-resisting "Powellium" nickel-bronze, plug type disc.

Fig. 559—125-pound Iron Body Bronze Mounted Swing Check Valve. Flanged ends, bolted flanged cap and regrindable, renewable bronze seat and disc. Disc, when wide open, permits full, unobstructed flow through the valve body. Also available in All Iron.

Fig. 6061 W. E.—Class 600-pound Cast Steel Swing Check Valve; with welding ends and bolted cap. Disc has ample lift to permit full, straightway, unobstructed flow through the valve when wide open.

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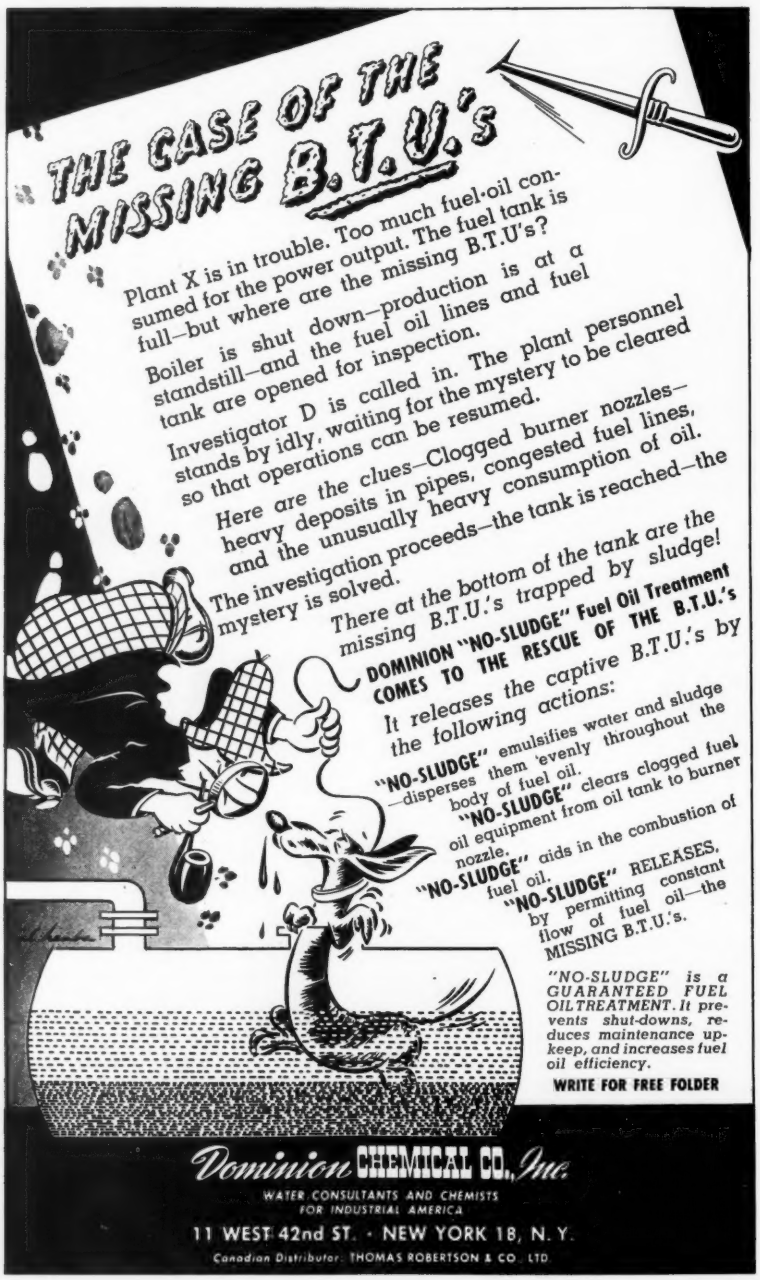
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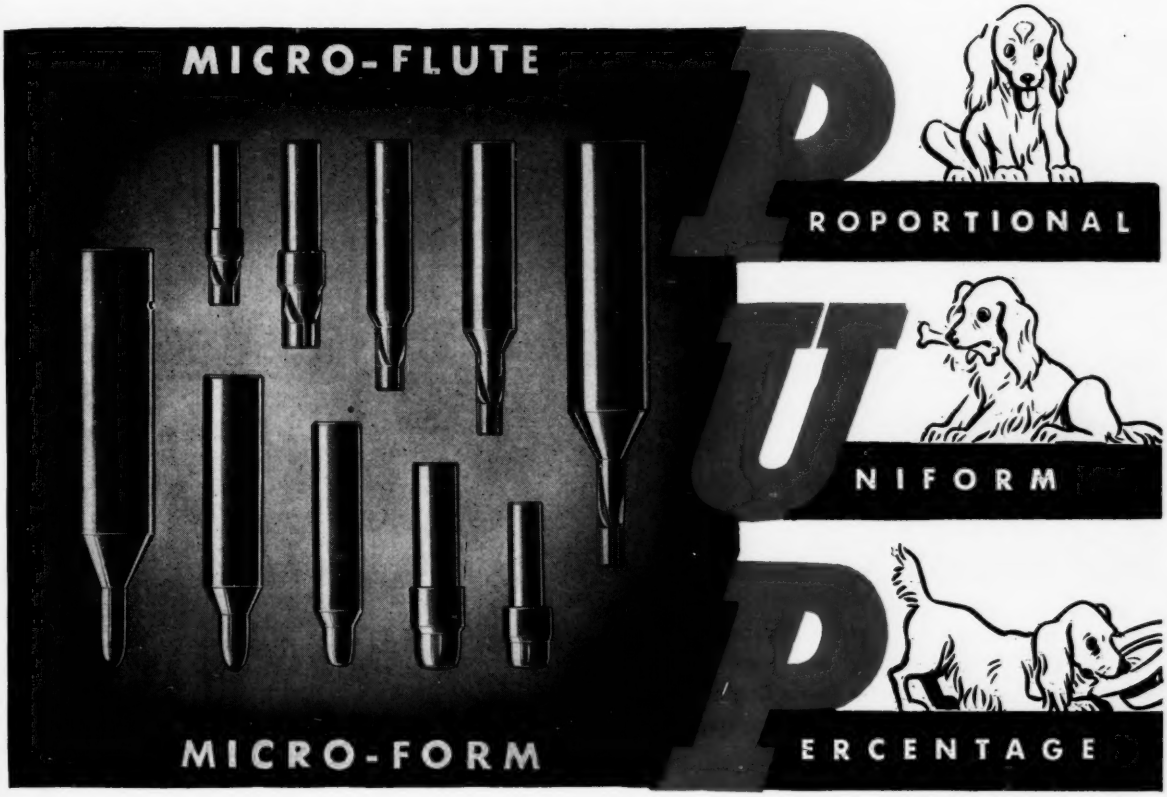

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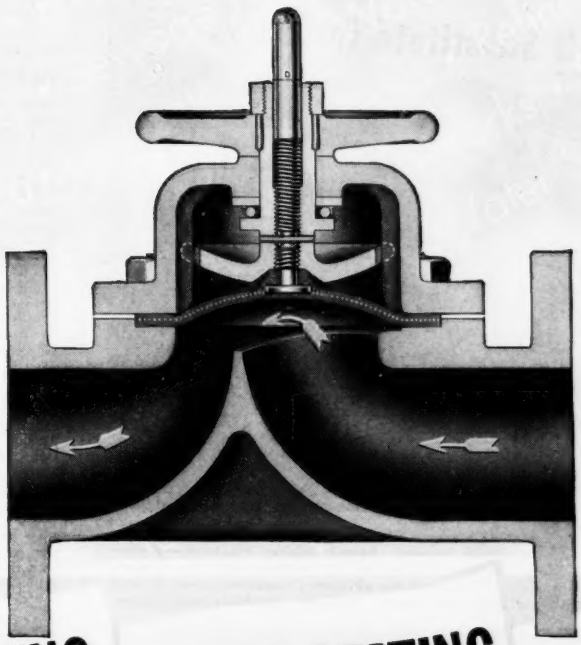
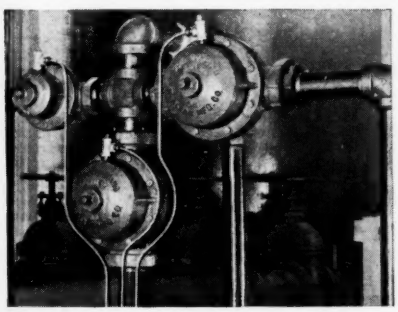
143 **Combustion Testing**—Bulletin 46-497; making combustion simple; how to run an orsat—pictures and directions; making draft survey; flue gas temperature; charts and drawings; 12 pages. The Hays Corp.



NO RE-PACKING ..NO RE-SEATING ...NO LEAKS!

...No Valve Trouble with McAlear No. M-1455 Diaphragm Valve

★ Pressure, Vacuum to 125 lbs. ★ Temperatures to 150° F. ★ Sizes ½" to 6"



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In refineries, chemical plants, processing and food plants—in sewage and waterworks—in power plants, paint factories and paper mills—in salt water service and in city deep well service, etc., McAlear No. M-1455 Diaphragm Valve has replaced many gate and other expensive types of valves.

This valve requires no re-packing, no re-seating, and cannot leak in any position. Closure is not dependent on metal-to-metal contact and diaphragm separates mechanism *completely* from fluids handled. Shut-off is positive, even with solids trapped on seat. Long-life diaphragm is replaceable with valve in line.

SPECIAL PRESSURE *operated types (see photo above) are available for automatic or pilot control. For complete data, write for Bulletin No. 118-A to McAlear Manufacturing Division, Climax Industries, Inc., 1915 S. Western Ave., Chicago 8, Illinois.*

McAlear Type H-850 LEVEL CONTROL with Type H-1410 PILOT

Wide throttling range—0 to 300%—or "snap" action. Size 6" diameter. Floats: 14" to 120". Working pressures 125 to 2500 lbs. Write for Bulletin No. 103.

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144 **Indicating, Control Systems**—What they are, what they can do; Bulletin 14B6641. Description of how transmitter, receiver and indicator of systems are constructed, how they work, their advantages and specifications. Illustrated with photographs, diagrams, charts; 12 pages. Allis-Chalmers Mfg. Co.

145 **Water Gages**—Condensed catalog, Bulletin E, of company's complete line of water gages. Each model illustrated and accompanying table gives sizing information; 8 pages. Ernst Water Column & Gage Co.

146 **Pyrometer Buyers' Guide**—Bulletin 100-1; illustrated table of contents, directions for selecting proper thermocouples, charts and diagrams. Detailed information includes complete description of material for assembled thermocouples and components; prices are listed; 40 pages. Brown Instrument Co., Div. of Minneapolis-Honeywell Regulator Co.

147 **Stainless Steel Bellows**—Bulletin SSB-46; contains diagrammatic cross-section views and up-to-date information concerning the use of these bellows as equalizers, compensators, expansion joints, flexible connectors, for flow control, vapor and steam traps, thermostatic instruments, etc. Completely illustrated; 12 pages. Chicago Metal Hose Corp.

148 **Pitot Equipment**—Three section Bulletin 50; gives complete details of the use of Pitot tubes and rods, instructions in the use of the company's portable Pitot recorder, together with theory, formulae, notations and curves. Completely indexed; 20 pages. Simplex Valve & Meter Co.

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150 **Instruments, Controls for Process**—Bulletin 17; process controllers, control components, measuring components and instrument combinations briefly described and illustrated. Application data such as sizes, pressure standards and ranges are listed; 8 pages. Bailey Meter Co.

151 **Temperature Regulators — Bulletin 7-A**; six types; descriptions, list prices, tabular material, photos; list of parts; typical installation drawings; tables for finding sizes of control valves required to heat given quantity of water; 16 pages. Atlas Valve Co.

152 **Feed Water Regulator**—Bulletin 8-A; description of operation; cycle of operation; full-page installation drawings; instructions for installing regulators; list prices and parts lists; 14 pages. Atlas Valve Co.

153 **Temperature Regulators**—Bulletin 6-A; for hot water heaters, storage tanks, etc.; what they do; operation; regulation; descriptions and drawings; list prices; applications; dimensioned drawings; installations; 20 pages. Atlas Valve Co.

154 **Draft, Excess Air and CO_2**—Bulletin 39-34†; discussion of the relation of these elements to the installation and servicing of bituminous and anthracite stokers by Arnold Soller; 12 pages. The Hays Corp.

PACKING, GASKETS

155 **Packings**—Bulletins P3, P14, P25 and P22; descriptions, tables of size and size number; tables of service for various packings. prices; 18 pages total. Greene, Tweed & Co.

156 **Packing**—Bulletin 237; photos and descriptions of use; installation drawings; standard size table; 4 pages. Warren Steam Pump Co., Inc.

FITTINGS

157 **Standards for Flanged Fittings, Valves, Flanges**—Pressure-temperature ratings, tables and charts, rating procedure, flange materials, safety factors, loading, stress formulas; 20 pages. Tube Turns, Inc.

158 **Welding Fittings**—Allowable working pressures; power, oil, district heating, refrigeration, gas and air piping; 14 tables and directions for use; 18 pages. Tube Turns, Inc.

159 **Welding Fittings**—Volumetric capacities; 2 pages of formulas for computation of capacities; 6 pages of tables; 12 pages in book. Tube Turns, Inc.

160 **Reference Tables and Data**—Bulletin 406; properties of saturated steam; velocities for fluid flow through pipes; saturated steam capacity

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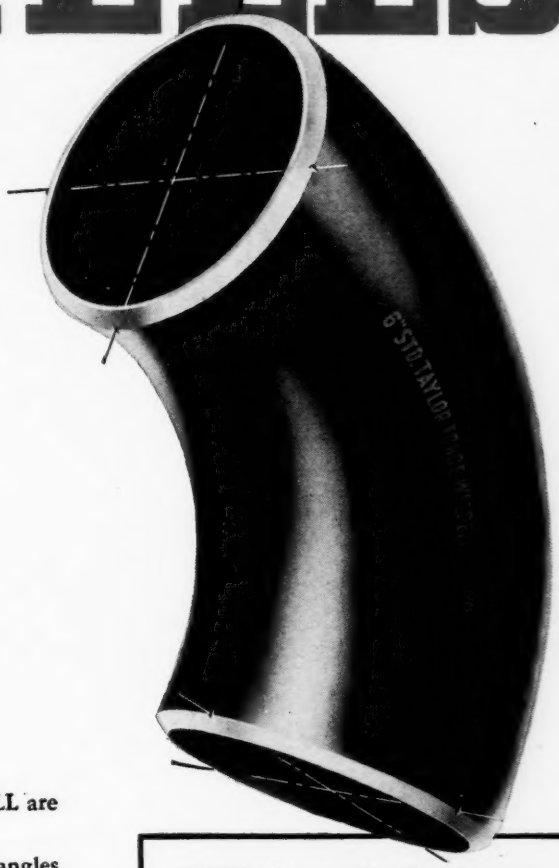

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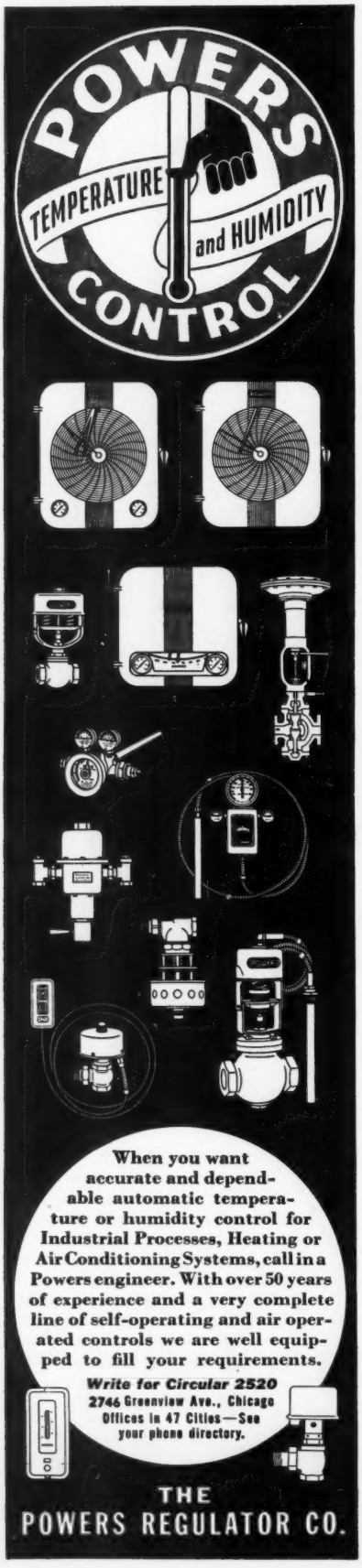

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of pipe; dimensions of extra-strong pipe; areas or circles and gal per ft of cylindrical length; engineering computations; 4 pages. Leslie Co.

161 **Unions**—Complete line of malleable iron unions and convenience unions; illustrations, descriptions, size and list prices; descriptions of materials and workmanship; 24 pages. Jefferson Union Co.

PUMPS

162 **Horizontal Duplex Piston Pumps**—Bulletin 230-1; specifications, steam end, liquid end; capacity tables for pressure service, light pressure service; dimensions, drawings, tables; 4 pages. Warren Steam Pump Co., Inc.

163 **Steam Heat Vacuum Pumps**—Bulletin 226-1; specifications, drawings, general information, tables of sizes and capacities; 4 pages. Warren Steam Pump Co., Inc.

164 **Centrifugal Pumps**—Bulletin 302-30, Revised; instructions for installation and operation; drawings, tabular material; 12 pages. Warren Steam Pump Co., Inc.

165 **Hydraulic Pressure Pumps**—Bulletin 238; specifications, sectional photos, important features; full page table of capacity, sizes, pipe sizes, pressure; 4 pages. Warren Steam Pump Co., Inc.

166 **Horizontal Duplex Plunger Pumps**—Bulletin 239; tables of sizes, capacities; important features, specifications; 4 pages. Warren Steam Pump Co., Inc.

167 **Controllable Capacity Pumps**—Data book 65; description, general design, method of operation; automatic control of pump delivery; drawings; adaptations, applications, power cost tables; standard sizes and ratings; 8 pages. The Aldrich Pump Co.

168 **Screw Pumps**—Recommended uses; advantages; tables of capacities and sizes; charts of test results; dimensioned drawings; suctions and discharge, packing box sizes, shipping weights tables; specifications; installation and maintenance; theoretical horsepowers; viscosity classifications; 18 pages. Sier-Bath Gear & Pump Co., Inc.

170 **Centrifugal Pumps**—Booklet describes basic action of centrifugal pumps, tells of the science of centrifugal action and the physics of pumping. Performance curves are presented. Descriptions of the company's self-priming centrifugal pumps are given and how they operate is explained. Typical uses of the units are pointed out and installation and operation explained; 20 pages. Marlow Pumps.

MISCELLANEOUS

171 **Whistles and Signals**—Bulletin 421; for industrial, marine, railroad service; selection; construction; advantages; operation; ordering and specifying; 8 pages. Leslie Co.

172 **Electric Tools**—Bulletin 464; covers complete line of portable electric tools for construction and briefly describes such tools as electric hammers, drills, chisels, vibrating tools, accessories, screw drivers, etc. Prices are given. Syntron Co.

173 **Refractory Concrete**—"Lumnite for Refractory Concrete"; basic information on materials and methods used in making refractory concrete. Illustrations show application of concrete in construction of furnaces, coke ovens, etc. Another section covers concrete use in foundations, floors and structures subject to high heat; 24 pages. The Atlas Lumnite Cement Co.

174 **Gas Purger for Refrigeration System**—Bulletin 160; tells how to cut power costs and raise condenser capacity by proper purging of non-condensible gases. Tables of ammonia properties, advantages and complete illustrated material. Typical installations are pictured. Two pages with diagrams tell how purger operates; 8 pages. Armstrong Machine Works.

175 **Grinding Wheels**—Grinding wheels of various abrasives are illustrated and list prices presented; tables of sizes in inches are accompanied by photographs and line drawings of these various wheels. Grinding wheel dressers with list prices are shown; 32 pages. Norton Co.

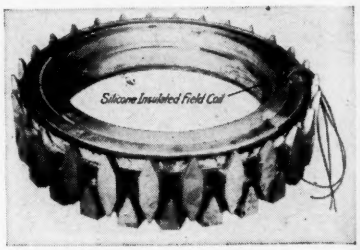
176 **Drop Forged Flanges**—Manufacturing processes; physical characteristics; full-page tables of illustrations, dimensions, weights and prices. Space provided for future insertions. Phoenix Mfg. Co.

177 **Fluid Handling Equipment**—Catalog 45; for industrial, power plant, process industries; descriptions, tables on strainers, valve control boxes, check valves, safety vents, foot valves, backwater sewer valves, interceptors, intercepting drains and traps, solids interceptors, lint interceptors, floor and area drains, etc.; completely illustrated; 12 pages. J. A. Zurn Mfg. Co.

Silicone News

DC SILICONES

DC Silicone Insulation Extends Life of Electro-magnetic Brake



PHOTO, COURTESY DYNAMATIC CORPORATION, SUBSIDIARY OF EATON MANUFACTURING COMPANY

Protects water cooled field coil in this magnetic field member.

In producing electro-magnetic brakes for well drilling rigs, the Dynamatic Corporation, of Kenosha, Wisconsin, tested and adopted DC Silicone Insulation. Moisture infiltration limited the life of coils treated with organic varnishes. Protected by DC 996, none of these coils has failed.

These brakes exert a variable and controllable retarding effect without friction or wearing parts. Fundamentally, they involve the rotation of an iron drum through a variable magnetic field created by stationary coils inside the drum. Eddy currents generated in the rotating drum exert on the rotor a torque which varies with the amount of current admitted to the field coils.

A heavy duty model absorbs up to 5,000 horsepower, providing speeds from 800 r.p.m. down to a rate that permits the setting of slips on the heaviest strings of drill pipe.

The permanently sealed field coils are cooled by water circulating over the field casting and eddy current members. But DC 996 excludes moisture indefinitely even at high operating temperatures. Insulation resistance remains high despite long exposure to weather when a rig is idle. And, when drilling is resumed, this resistance rises rapidly and soon reaches infinity.

DC 996 is described in leaflet No. M 3-4.

NOTE: See our Exhibit at the Electrical Engineering Exposition, New York, January 27 to 31.

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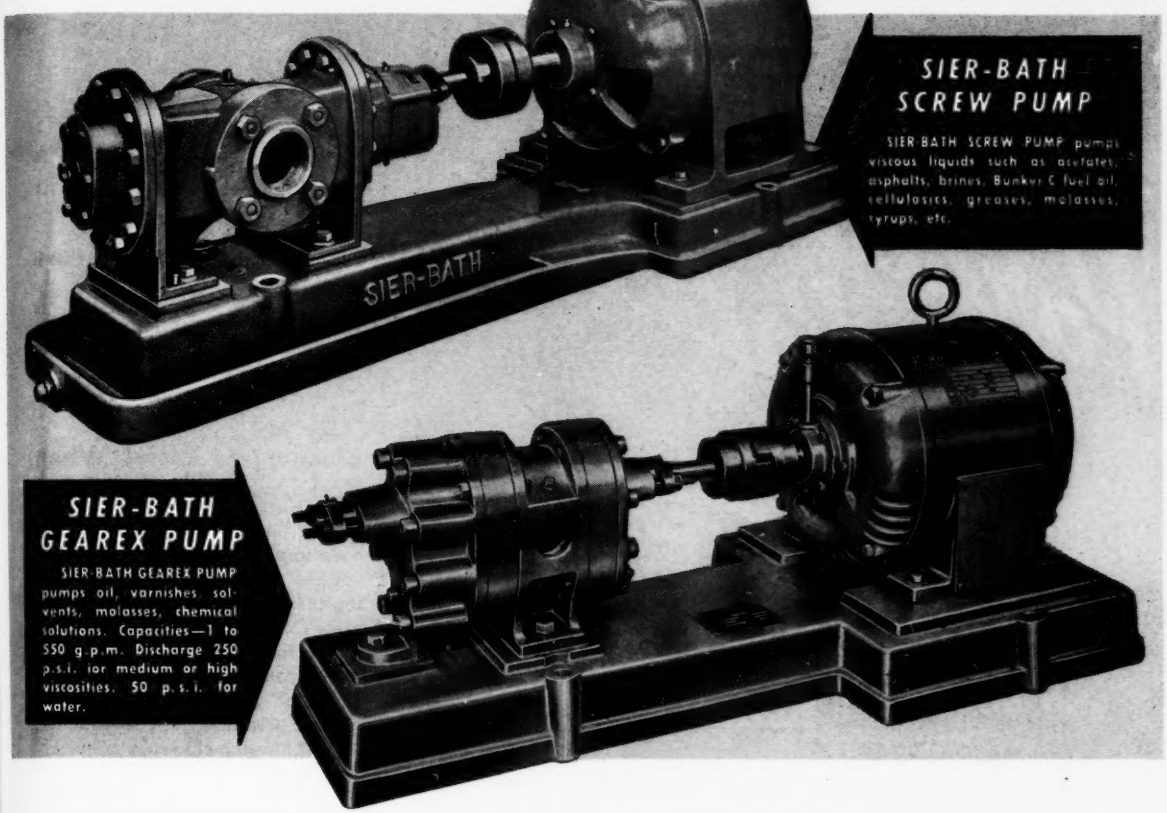
FIRST IN SILICONES

SIER-BATH ROTARY PUMPS

are the natural offspring of PRECISION GEAR manufacturing


SIER-BATH
SIER-BATH SCREW PUMP
SIER-BATH SCREW PUMP pumps viscous liquids such as acetates, asphalts, brines, Bunker C fuel oil, cellulosics, greases, molasses, syrups, etc.
SIER-BATH GEAREX PUMP
SIER-BATH GEAREX PUMP pumps oil, varnishes, solvents, molasses, chemical solutions. Capacities—1 to 550 g.p.m. Discharge 250 p.s.i. for medium or high viscosities. 50 p.s.i. for water.

The better the gears and screws, the better the pump. Sier-Bath has been noted for designing and making the finest precision gears obtainable, for many years. Therefore, it is natural that Sier-Bath Gearex Pumps and Screw Pumps should have gained a high reputation for quality of service, in the short time since they were introduced.

Both the Sier-Bath Gearex Pump and the Screw Pump are made in horizontal and vertical models. They operate without vibration and discharge liquids without pulsation. Minimum wear and maximum life are assured because rotors are not in contact. Needle bearings maintain precision operation and provide greater load carrying capacity.

In every way, Sier-Bath Gearex Pumps and Screw Pumps are designed and produced to operate with the least possible maintenance. Write for detailed information.

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FULLY AUTOMATIC

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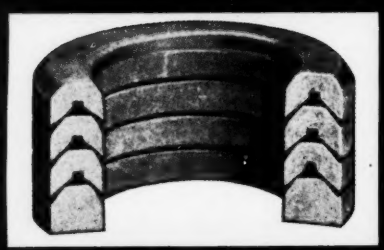

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You, too, will find the National Girth Seam Protector saves trouble and money by preventing leaks and fire-cracking on new or old seams in boilers. Sections consist of wedge nut, cap screw metal lug and refractory covering; are easily attached. We can make immediate deliveries. Send for descriptive bulletin.

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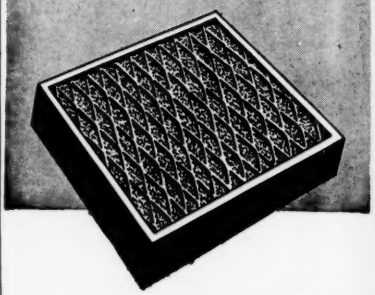

Air conditiong efficiency starts with your air filters. When units are CLEAN . . . when maintenance is regularly performed . . . high filtering capacity is assured and the system can function at peak effectiveness.

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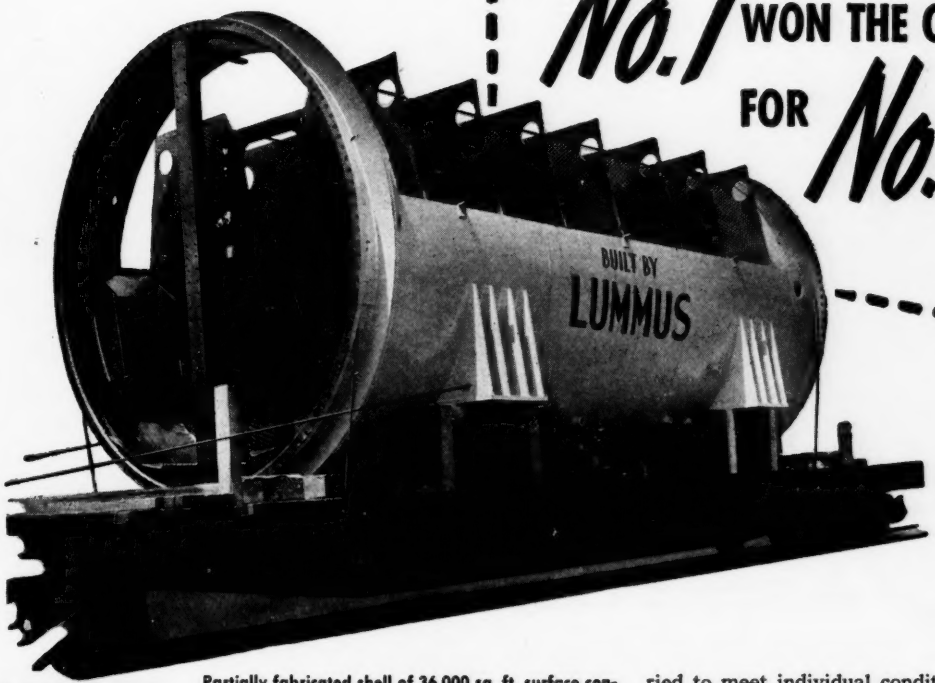

Partially fabricated shell of 36,000 sq. ft. surface condenser. The second of two supplied—complete with air ejector and all appurtenances—to a prominent utility

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Lummus designs and builds a complete line of surface condensers and other heat-exchange equipment for stationary and petroleum-refinery applications. Write for full information.

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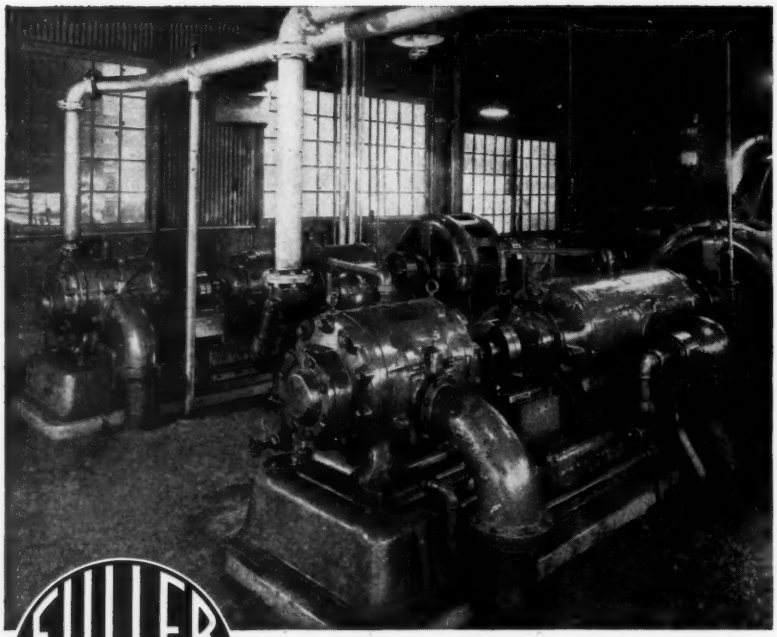

FULLER ROTARY COMPRESSORS

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Another Steel Mill Installs Fullers

Steel mill superintendents have learned that Fuller Rotary Compressors really fill the bill in their business. Hundreds of them are now in use throughout the industry. They're easy to install, don't require large, heavy foundations with relation to capacity when compared with other types of compressors. Then too, Fullers give them the original capacities for the life of the machine.

Write for Bulletin C-5

Fullers have a minimum of moving parts, only three: rotor - bearings - blades. Really built for severe service. And, when repairs are necessary, easy access to the machine allows the work to be done with minimum time loss.

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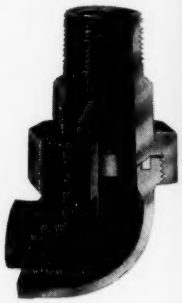
C-127

FULLER

PIONEERS OF HIGH-EFFICIENCY ROTARY COMPRESSORS

JEFFERSON *Specialty* UNIONS

Featuring the **RECESSED BRASS SEAT**



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Savings in original installation through the use of Jefferson Specialty Unions is effected through simplification in piping and in the time and labor involved in making up joints. Once the installation has been made savings in maintenance are assured because there are fewer joints involved at points where unions can be most effectively employed.

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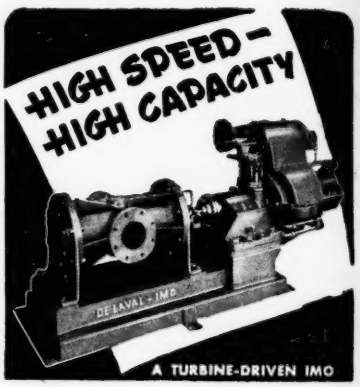

The IMO PUMP provides a maximum of capacity in a minimum of space due to the fact that it can be operated at high speeds connected directly to motor, turbine or other machinery.

Where space is a problem install IMO—the reliable rotary, positive displacement pump having only three moving parts and no gears, pistons, sliding vanes or valves.

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IMO means I MOVE OIL

IMO PUMP DIVISION of the
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as advanced by

CHICAGO METAL HOSE CORPORATION

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the science of FLEXONICS ..."the controlled bending of thin metals for use under varying conditions of temperature, pressure, vibration and corrosion"—is exemplified in the basic products of Chicago Metal Hose Corporation.

• Rex-Weld, Rex-Tube and Rex-Flex are *branded* flexible metal hose. Each of these—as well as C.M.H. Stainless Steel Bellows, Compensators and allied products—is manufactured with the increased product knowledge which the Science of Flexonics makes possible.

Chicago Metal Hose Corporation continues to devote its energies to this science. Just as C.M.H. has developed new *basic* products in the past, so it continues that development. These accomplishments—and this continued progress—have resulted in recognition of Chicago Metal Hose as the leader in the design and manufacture of flexible metal hose and allied products. For product application guidance, C.M.H. has data available—derived from the Science of Flexonics. Chicago Metal Hose Corporation welcomes the opportunity of putting its knowledge of this science to work for you.

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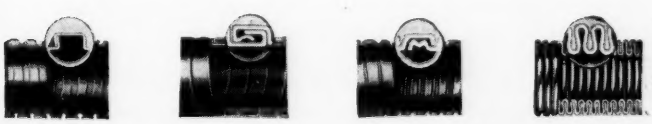

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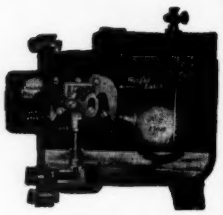
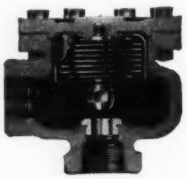


Advance-Type Drainage Methods

are discussed in our trap

Catalog 444

This helpful standard reference book will be gladly sent you.



WEIGHT-OPERATED TRAPS — (above) Three types, for steam, air, gasoline. Pressures to 1500 lbs.

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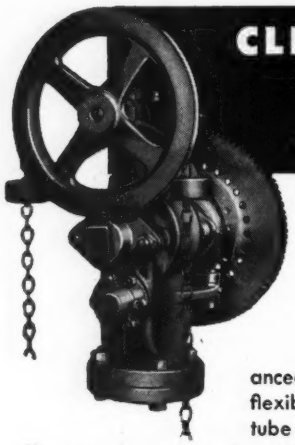

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POWER PLANT ENGINEERING

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2. **Resistance to Heat, Corrosion, Abrasion.** With aggregate selected according to service requirements, LUMNITE makes concrete to withstand high temperature, sulphurous flue-gas and fly-ash, or corrosion from bunkered coal and cinders.

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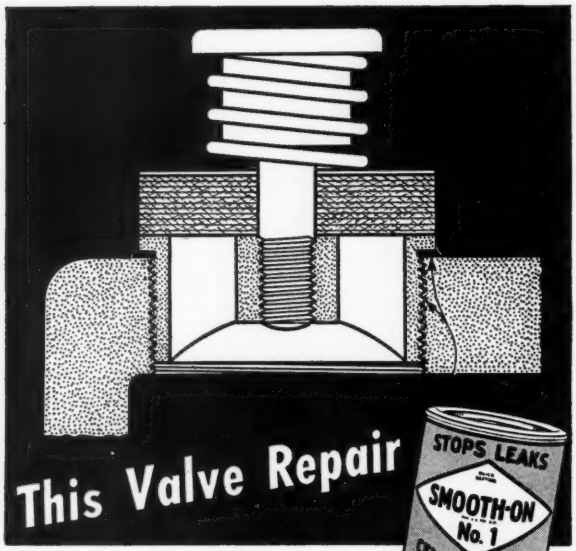

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POWER PLANT *Construction News*

Ala., Gadsden—Alabama Power Co., Alabama Power Building, Birmingham, Ala., has plans in progress for new steam-electric power plant at Gadsden, with installation to include two 60,000-kw turbine generators, high pressure boilers and auxiliary equipment. Capacity will be increased at later date and additional genertors installed. Extensions will be made in transmission lines, switching stations and other operating facilities. Cost estimated close to $10,000,000. Work will be placed under way in 1947.

Ark., Prescott—Town Council plans power substation for connection with new transmission line to be constructed by Arkansas Power & Light Co., Pine Bluff, Ark., from Gurdon to Prescott, for additional power supply for local community, augmenting service from municipal power station. Installation will include transformers, switchgear, voltage regulator and accessory equipment.

Ariz., Phoenix—Water Department, Phoenix, plans installation of booster pumping station in connection with extensions and improvements to water supply system. It will be equipped with pumping units, controls and auxiliaries for capacity of about 50,000,000 gal. per day. Entire project is estimated to cost about $1,600,000. Johannessen & Girand, First National Bank Building, Phoenix, are engineers.

Calif., Los Angeles—Bureau of Water and Power, 207 S. Broadway, has plans maturing for proposed new steam-electric generating station at Island Ave. and B. St., Wilmington district, with turbine generators, high-pressure boilers and auxiliary equipment for large capacity. Cost reported about $4,000,000. CPA has approved project and work will be placed under way soon.

Calif., Trona—American Potash & Chemical Corp., 609 S. Grand Ave., Los Angeles, Calif., borax, boric acid, potash, etc., plans installation of electric power equipment in new additions to mill at Trona, comprising several units for a complete carbonation plant. Cost reported about $4,500,000. Company also will make extensions in power plant at mill, with equipment for considerable increased capacity. Cost estimated close to $2,000,000. Project has been authorized by CPA and will be placed under way soon.

Ga., Albany—Clark Thread Co., Austell, Ga., plans new mill at Albany, comprising a main one-story building and several auxiliary structures. Electric power equipment will be installed. A power substation and boiler house are planned. Cost estimated about $500,000. A similar branch mill is proposed at Thomasville, Ga., to cost approximately a like amount.

Ill., Venice—Union Electric Co., 315 N. 12th Blvd., St. Louis, Mo., has plans maturing for addition to steam-electric generating station at Venice, and will begin work early in 1947 on steel frame superstructure. Additional equipment will be installed for increased output. Stone & Webster Engineering Corp., 49 Federal St., Boston, Mass., is consulting engineer.

La., Rayne—Municipal Water & Light Department, W. Texas Ave., has plans maturing for extensions in municipal power plant, including installation of new Diesel engine-generating unit and auxiliary equipment. Proposed to carry out work soon. Barnard & Burk, Triad Building, Baton Rouge, La., are consulting engineers.

Md., College Park—Board of Directors, University of Maryland, is considering new boiler plant for central-heating service at local institution, reported to cost about $950,000, with boilers, pipe lines and accessory equipment. This will be part of a general expansion and improvement program at college, to represent large total investment.

Minn., Lake Benton—Village Council has surveys and plans under way for new municipal power plant, using Diesel engine-generator units and auxiliary equipment. Long & Thorshov are architects, and Ralph D. Thomas & Associates, Inc., consulting engineers, both 1200 Second Ave. S., Minneapolis, Minn. Cost estimated close to $200,000.

Minn., Marshall—Town Council plans installation of a central-heating system in downtown district, using municipal power plant as source of steam supply. Surveys and plans are being made by Ralph D. Thomas & Associates,

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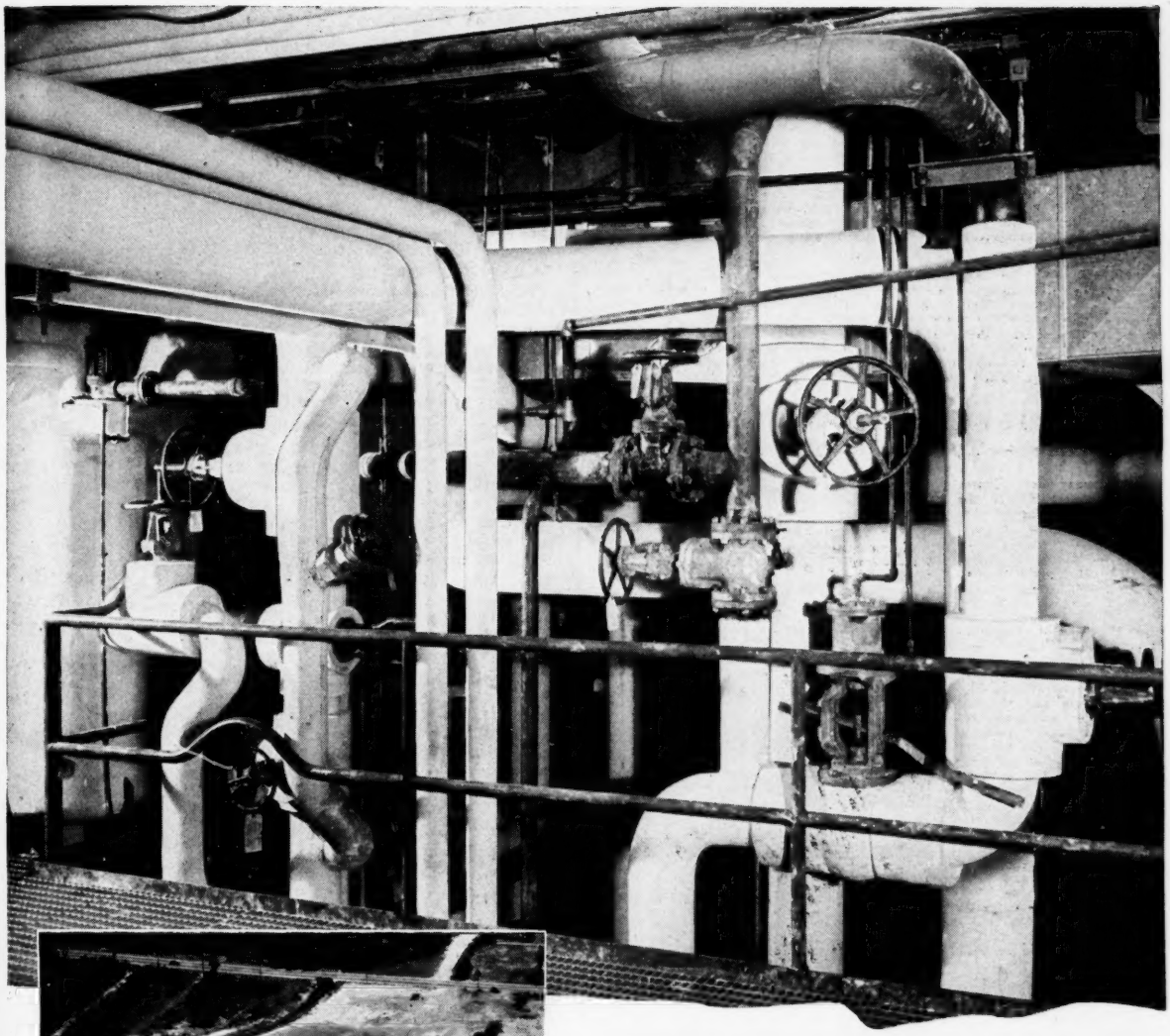

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Inc., 1200 Second Ave. S., Minneapolis, Minn., consulting engineers. Cost estimated about $200,000.

Miss., Ripley—Town Council plans installation of a municipal natural gas distribution system, with control station and pressure pipe line for connection with supply source. Cost estimated about $225,000. Surveys and plans are under way.

Mo., Fulton—Municipal Water, Light & Power Department has plans maturing for expansion and improvements in municipal steam-electric power station, with installation of equipment for increased capacity. Bond issue of $200,000 has been authorized for project. Burns & McDonnell Engineering Co., 107 W. Linwood Blvd., Kansas City, Mo., is consulting engineer.

N. J., Rahway—Merck & Co., 126 Lincoln Ave., drug and pharmaceutical products, plan installation of electric power equipment in new addition to plant for processing and laboratory service. Also will make extensions and improvements in power house, with installation of equipment for increased capacity. Entire project estimated to cost about $1,429,000. Work will be carried out soon. CPA has approved project.

N. Y., Port Jefferson—Long Island Lighting Co., 250 Old County Rd., Mineola, L.I., plans new power plant at Port Jefferson, with turbine generators, high-pressure boilers and auxiliary equipment for large capacity. Cost reported about $3,800,000, with transmission lines for connection with present system and other facilities.

N. Y., Rochester—Rochester Gas & Electric Corp., 89 East Ave., has plans under way for new steam-electric generating station on site near city, fronting on Lake Ontario. Installation will include 40,000-kw turbine generator, high-pressure boiler and auxiliary equipment. Project will include extensions in transmission lines for connection with present system and other facilities. Cost estimated close to $8,000,000, with completion scheduled in 18 to 24 months. Provision will be made for installation of three additional units of same rating at later date.

Ohio, Toledo—Toledo Edison Co., Edison Building, has plans for new addition to generating station. Award has been made for steel frame superstructure and work is scheduled to begin soon. Equipment will be installed for increased capacity.

Ohio, Toronto—Ohio Edison Co., Youngstown, Ohio, plans extensions and improvements in coal storage and coal-handling equipment and facilities at local generating station, reported to cost close to $175,000.

Pa., Norristown—Philadelphia Electric Co., 1000 Chestnut St., Philadelphia, Pa., has authorized plans for expansion in generating station at Norristown, known as Barbadoes Island Plant. Installation will include two turbine-generator units, high-pressure boilers and accessory equipment. Cost reported about $5,000,000, including extensions in transmission lines.

R. I., Providence—Narragansett Electric Co., 51 Wesminster St., has authorized further expansion in Manchester St. generating station, to follow project now in progress at that plant, including installation of a 40,000-kw turbine generator and accessories, scheduled to be ready for service in 1947. New York will comprise another generating unit of similar capacity, high-pressure boiler and auxiliary equipment, as well as additional coal-handling facilities. Program will represent an investment of about $7,000,000, and will be completed in 36 to 48 months.

S. C., Lancaster—Spring Cotton Mills, Lancaster, has authorized plans for new steam power plant at dyeing and finishing works now in course of construction on site distant from present mill. New generating station is estimated to cost over $250,000. Proposed to carry out construction by day labor and individual contracts for different branches of work. E. L. Scruggs is chief engineer.

Va., Alexandria—Braddock Light & Power Co., 929 E. St., N.W., Washington ,D.C., has plans maturing for new generating station at Alexandria, with initial capacity of about 80,000-kw. In addition to generator units, installation will include high-pressure boilers and accessories. Cost reported in excess of $3,000,000. Stone & Webster Engineering Corp., 49 Federal St., Boston, Mass., is consulting engineer. Company is an interest of Washington Railway & Electric Co., Washington, D.C.

Va., Richmond—Virginia Electric & Power Co., Franklin and Seventh Sts., plans new high-tension substation in Fairfax County, exact location to be determined soon, with transformers, switchgear and accessory equipment for large capacity. Also will make extensions in transmission lines in same area.